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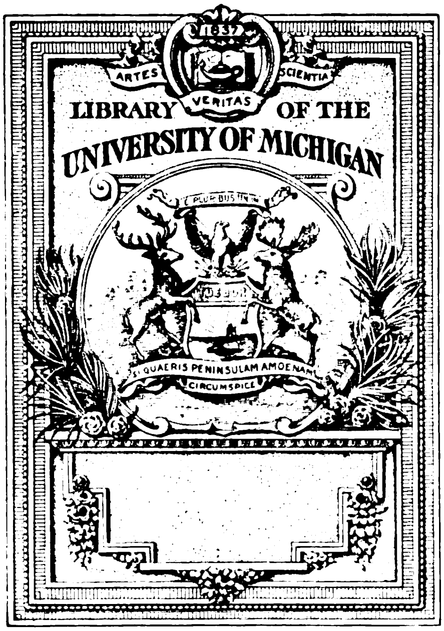

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THE PHYSICAL FEATURES OF NEW ZEALAND.

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INTRODUCTION.

Perhaps no other country in the world can marshal in so small a space such a marvelous array of physical features as the islands of New Zealand. The whole area of the young British Dominion amounts to only 104,751 square miles, an area less than that of Great Britain. Yet here the traveler may see thermal phenomena as wonderful as those of the Yellowstone in America; may behold great steep-walled, deep-watered sounds, bordered by a vegetation of almost tropical luxuriance, and resembling in mode of origin the famed fiords of Scandinavia; and may climb great snow-clad peaks or explore huge alpine snow fields, rivaling those of the Alps, the Caucasus or the Himalayas.

New Zealand consists chiefly of two islands of almost equal size and known respectively as the North and the South or Middle Island. Just south of the latter is Stewart Island, which is much smaller than either of the others. A number of islands lying at varying distances off the coast are under the government of New Zealand.

GENERAL GEOLOGY.

In the South Island the Southern Alps and the several parallel and subsidiary ranges which extend in almost every direction consist mainly of much metamorphosed and deformed Palæozoic and early Mesozoic sediments, while the greater part of the flat-lying land is overlain by Tertiary or even more recent strata. The sedimentary rocks are frequently much shattered and readily friable.

Igneous rocks, though presenting a marvelous variety of petrographical forms, compose only a small portion of the South Island. Volcanic rocks, however, form almost the whole of Banks Peninsula, and they are also prominent near the city of Dunedin, whilst plutonics are represented in the granite buttress forming the south-

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western corner of the island and in the ridges of the same rocks stretching northward from this buttress parallel with the western seaboard. Ultra-basic rocks occur to a very limited extent at intervals along the western side of the main divide southward from the town of Nelson.

The oldest rocks of the North Island are easily weathered Triassic and Jurassic strata, which compose the main massif of the mountain chains. Overlying these, Tertiary beds of varying age form the Wanganui Coastal Plain, as well as the relatively low-lying country in the Poverty Bay and Hawkes Bay districts, and are also prominent in the valley of the Wairarapa and elsewhere.

In much of the central and northern part of the North Island, tufa and lava, both of Tertiary and of Pleistocene age, overlie the sendimentaries and form in many places a hard and resistant covering.

THE SURFACE OF THE LAND.

Like Scandinavia or Japan, New Zealand is mountainous, and though there are several relatively wide stretches of flat-lying land, they are inextensive compared with the widespread hilly or more elevated country. An Irish whaler who visited our shores in the early days is said to have laconically remarked, "New Zealand would be a fine large country if it were rolled out."

The backbone of the South Island is formed by the Southern Alps. In the northwestern part of the same island two prominent ranges known respectively as the Seaward and Landward Kaikouras run nearly parallel to the northern continuation of the Southern Alps, here known as the Spencer and St. Arnaud mountains. In the northwestern part of the South Island a maze of ranges known under many names is subsidiary to the principal chains of the Alps.

In the North Island an unbroken chain of mountains runs from Wellington to the East Cape. This chain is known under various names, the best known of which are the Rimutakas, the Tararuas, the Ruahines, the Huiaraus and the Raukumaras. Parallel to this main chain on the east side are the Maungarahi Mountains and the Puketoi Hills, and on the other side the Kaimanawas. Other low ranges of mountains form the backbones of the North Auckland

Mt. Cook (12,349 ft.) and Hochstetter Ice Falls. (Ice falls are two miles across at widest part.) (Photo by New Zealand Tourist Department.)

Another View of Mt. Cook (12,349 ft.) The glacier-fed Hooker River in foreground. (Photo by New Zealand Tourist Department.)

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and Coromandel peninsulas, the latter range extending southward therefrom into the heart of the island.

The highest land in New Zealand is formed by the lofty snow-clad crests in the heart of the Southern Alps. The culminating point is Mt. Cook, a splendid double-crested monolith which rises to a height of 12,349 feet. Around it rise in a veritable *mer des montagnes,* to heights of over 10,000 feet, many other stately peaks, among which lie spacious fields of névé from which emanate many great glaciers later to be described.

In the North Island the highest altitudes do not occur on the ranges of sedimentary strata enumerated above, but are instead volcanoes which are youthful in age compared with the old and well-dissected mountains around them.

The beautiful symmetrical cone of Mt. Egmont rises from the flat land of the Wanganui Coastal Plain to a height of 8,250 feet, while Mounts Ruapehu (9,175 feet) and Ngauruhoe (7,515 feet) are surrounded by extensive lava and tufa plains, which form the Taupo Plateau.

The mountains composed of Mesozoic or earlier rocks, wherever they occur, whether the lofty Southern Alps or the inconspicuous sedimentary ridges of the North Auckland Peninsula, by their even skyline, which is quite independent of the structure of the Palæozoic and Mesozoic rocks of which they are composed, show in their crests the remnants of an elevated flat or relatively flat surface, representing an old plain of erosion, or peneplain. Of course, since the mountains in one part of the country show marked variations in altitude from other parts, it follows that this apparently uniform crestline must not be representative of the country as a whole, but only of the area seen from a particular viewpoint.

The widespread Miocene rocks, faulted and tilted but not folded, which occur in many parts of New Zealand, ranging in altitudes from sea level to over 4,000 feet, show that the land surface of New Zealand was then in great part depressed beneath the sea. At the same time occurred the maximum development of the peneplain resulting from the prolonged denudation of the surface of highly corrugated Palæozoic and Mesozoic rocks, which probably had formerly risen to almost mountainous heights. The principal mountain ranges as we know them to-day are then the product mainly of differential movements, very broad folding, deformation, and tilting, which succeeded Miocene times and elevated the old base-levelled surface to the varying heights seen from many aspects.

Countless centuries of erosive activity in a country in which change is rapid have greatly altered the original flat surface of the various up-lifted and tilted blocks. Far and wide the land has been deeply dissected, and valleys—broad towards the sea but narrow in the mountains—have been formed between the ridges. The amount of dissection has been greatest where the old surface was most elevated, in the Alpine block, since here the precipitation was at the maximum and the country most exposed to denudation owing to changes of temperature. The maze of ridges of rugged topography, the serrate crests, the aiguille-shaped peaks show but little of the old peneplain surface. Elsewhere, however, where not raised to such high levels and where protected by a dry climate from excessive denudation, the surface is less changed. Thus in the South Island one sees isolated remnants of this ancient plain in the tussock-clad Gouland and Gunner downs of the Nelson Province, and in the broader expanse of the arid Central Otago Tableland. Here in Central Otago various horsts higher than the general level of the old plain rise as well-demarcated block mountains.

In the North Island the evidence of the old base-level is almost completely obliterated by numerous tectonic and erosive changes, which have occurred either during or since the uplift of the land after Miocene times.

Various small blocks of the old plain, each with its uniform or nearly uniform crestline, are seen around the capital city, Wellington, and again in the far north near the Bay of Islands. In the central and southern portions of the South Island the mountains, owing mainly to the recent very great and still present glaciation exhibit a rugged topography. Precipices are common and solid rock shows in many places, even on the more gradually sloping hillsides. However, scree slopes are general and are especially conspicuous on the eastern part of the Alps, where in places they extend well beyond the actual base of the hill or mountain which they border as veritable rock rivers.

At the northern part of the South Island and in the North Island the topography is much more subdued; the hills show a general absence of rock faces, and almost everywhere a dense vegetation grows on the soil-covered hills.

The most extensive area of flat-lying land in the South Island is formed by the Canterbury Plains, which, free from brush and with a good soil, first became the home of white settlers between sixty and seventy years ago. Now the plains are thickly settled with towns, villages and well-tilled farms, whilst sheep-runs extend on to the foothills and up the alpine valleys in the mountains themselves.

The Canterbury Plains gradually increase in altitude from sea level to a height of about 1,000 feet at their inner margin. Their surface is composed of gravel and finer débris brought down by the numerous large streams which flow from the perennial alpine snows. The gravels, as already remarked, are superimposed upon a basement of Tertiary strata with a gradual seaward tilt from the base of the mountains. Thus it seems evident that the Canterbury Plains are the result of the coalescence of numerous alluvial fans on top of a coastal plain.

The hills at the eastern edge of the Canterbury Plains forming Banks Peninsula are almost entirely of volcanic origin and are younger than the Alps to the west.

At the western base of the Southern Alps lies the narrow Westland lowland stretching along a wild harborless coast for upwards of 100 miles. Like the Canterbury Plains, the Westland lowland is in great part formed of material derived from the Southern Alps. Its surface is covered partly by fluviatile deposits, partly by widespread morainic deposits, the product of the ancient piedmont glaciers that formerly shrouded the lowlands and extended into the ocean itself. On account of the irregular relief produced by the glacial material, and on account of the modern uplift and dissection of the northern portion the Westland lowland can hardly be called a plain. This area with its dense forest, humid climate, and relatively infertile soil, was naturally unattractive to the pioneers of New Zealand settlement, and it was not until the discovery of rich gold-bearing placers in 1864 and succeeding years that any serious occupation of Westland began. Even now it is sparsely settled, save in the lower river valleys, and is still in great measure covered by a magnificent and luxuriant forest.

The fertile Southland plains, dotted with farms and villages, resemble the Canterbury plains in origin.

Between the Southland and Canterbury plains are scattered among relatively low out-lying ridges a number of flats, filling old lake basins in the schist rocks. The material of which their surfaces are formed has been laid down by the rivers that flow through them. In the northern part of the South Island the Aorere Plain, the Takaka Plain, and the Waimea Plain, all inextensive in area but with fertile land, are the results of river sedimentation in limited depressions, due partly to tectonic subsidence and partly to fluviatile erosion.

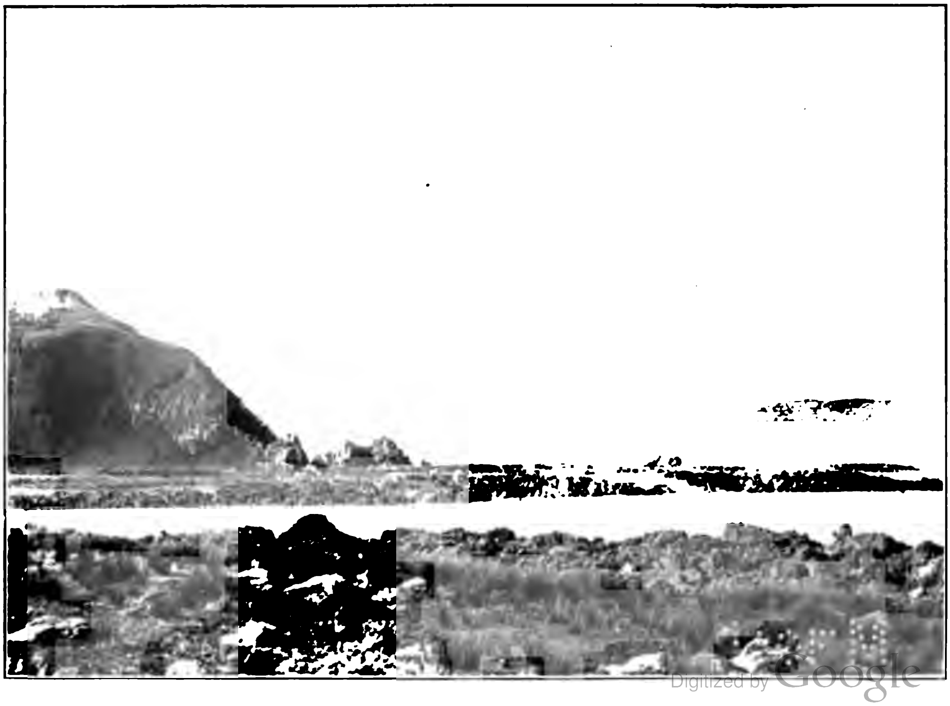
In the North Island, east of the beautiful volcanic cone of Mt. Egmont, lies an extensive plain, which, gradually narrowing, extends northward almost as far as Kawhia and southward almost to Wellington. This plain is formed by a great thickness of marine Tertiary rocks with a very gradual inclination toward the sea from the mountains of pre-Tertiary and of later volcanic rocks in the interior. Though the surface of the plains is still in great part intact, its level expanse is deeply cut into by numerous streams which are bordered by broad flood plains. Settlement began on the coast of this plain in the early forties of the last century, but received many set-backs owing to the Maori wars. Even yet much of the plain, almost everywhere fertile, is densely covered with forest.

Between Palliser Bay and Hawkes Bay lies a narrow but relatively extensive area of rich flat-lying land, the material of which is thought to be formed by the deposits of an ancient river—the ancestor of the present Wairarapa.

The Waikato Plain covers a large stretch of country, traversed by the Waikato River in its middle course. Its surface is largely composed of fairly fertile soil, but some portions are poor and others swampy.

The Piako Plain which extends southwards from the Firth of Thames contains a considerable area of good land, but much also is relatively poor. Its surface, in general swampy, is but little elevated above sea level. Its population as yet is scant, but an extensive drainage scheme now being carried out will, it is thought, greatly increase the value of the land. The plain is the result of the deposition of fluviatile material (mainly originally volcanic) in a

The Remarkables and Lake Wakatipu. (Photo by New Zealand Tourist Department.)



View of Shore Line near Entrance to Wellington Harbor, showing earthquake-raised beach.

long narrow arm of the sea, of which the Firth of Thames is the diminished remnant.

The Kerikeri Plain, which extends westward from the Bay of Islands in the North Auckland Peninsula, is composed of horizontal or almost horizontal lava flows, which overlie the much denuded and here low-lying remnants of the ancient peneplain. The plain has an infertile soil and is now almost treeless. Formerly, however, a vast kauri forest grew upon it, and the digging of the fossil gum derived from this source forms the main industry of the very heterogeneous though sparse population of this part of the country.

As already remarked, the center of the North Island is marked by an extensive volcanic plateau, which includes the volcanic zone. The plateau consists geologically mainly of beds of rhyolitic tuffs and agglomerates more or less reassorted by water, and lying generally in an almost horizontal attitude. Toward the Bay of Plenty the plateau is not of great altitude, but toward the interior it rises to over 3,000 feet. For long distances its surface is almost level, being broken only by the deep narrow valleys of the numerous water courses. Elsewhere it is more undulating. The greater portion is free from large timber, and in some places it is quite barren. For the most part, however, a thin growth of bracken and manuka covers the surface, presenting an appearance much the same as the sage brush of the western states. The great incoherence of the loose pumiceous soil forms the chief cause of the barrenness of the locality. Consequently there is but little settlement, save around the various spas at the centers of hydrothermal activity. Of these, popular interest centers around the town of Rotorua, and the settlements of Whakarewarewa, Wairakei, Taupo and Tokaanau.

Numerous volcanic cones, some seemingly quite extinct, some apparently merely quiescent, and others still active, rise above the level of the plateau. Of these the most important in the northern part of the plain is the volcanic peak of Tarawera, which suddenly burst into violent eruption in June, 1886. The mountain had never been active in the memory of the Maoris previous to this date, and as it was covered by a growth of high timber and showed no evidence of recent activity, it had probably been quiet for many centuries prior to the sudden outbreak. By the eruption the configuration of the surrounding country was much changed; the world-famed pink and white terraces were destroyed, and the small basin of old Lake Rotomahana, now occupied by the waters of a new and greater Lake Rotomahana, was much enlarged. Numerous craters were formed along a great rift line stretching nine miles southeasterly from the volcano itself, and new geysers and other hydrothermal phenomena appeared.

North of Lake Taupo stands the beautiful symmetrical cone of Tauhara, while to the southward thereof rise the various peaks of Tongariro Ridge—Mt. Ngauruhoe and Mt. Ruapehu. Mount Ngauruhoe is continually active, its activity generally consisting of explosions of steam laden with hydrogen sulphide emitted from several holes in the bottom of the spacious crater. From time to time, however, there are spasmodic outbreaks of volcanic dust on a rather inextensive scale. Lava has not recently issued from the crater, though it is said to have been emitted during the early part of the last century. A fresh flow on the western side of the mountain seems to give visible evidence of this fact.

Unlike Ngauruhoe, which is mainly a scoria cone, Ruapehu is made up chiefly of volcanic flows. Its crest rises beyond the level of perpetual snow and consequently several small glaciers—the only ones in the North Island—descend its much scored slopes. On its summit is a small crater lake, surrounded for the most part by ice. The pond is generally steaming, and occasionally violent outbursts take place which cover the white snow of the mountain with a gray dust.

Hot springs occur at many places on the Taupo Plateau, but geysers are now practically limited to Whakarewarewa, Wairakei, and Taupo. By far the greatest geyser, Waimangu, which broke out in January, 1900, and is believed to have been an after-effect of the Tarewera eruption, was situated on the line of the Tarawera rift not far from Lake Rotomahana. After remaining active for several years it became quiescent during July and August, 1904. The geyser renewed its eruptions with, if anything, increased vigor during the next two months, but the last great outburst took place on October 31, 1904. There was a slight eruption next day, but since then Waimangu has been entirely inactive and is therefore probably extinct. The great geyser was a hydrothermal phenomenon of highly impressive magnitude. In the most violent eruptions water, thickly charged with mud and stones and even with huge boulders, was ejected 1,500 feet into the air with terrific force and with awe-inspiring roar.

Outside the Taupo volcanic zone proper hot springs occur at Te Aroha and several other places in the North Island. In the South Island there are hot springs on the Hanmer Plains in Canterbury and in many of the western river valleys in the Southern Alps.

DRAINAGE.

In New Zealand the normal drainage of the country has been much complicated, by extensive glaciation in the past in the South Island, and in the North Island by tectonic movements and by volcanic outbursts.

In the various rivers descending from the Alps across the Canterbury Plains large rapids, and in the minor streams waterfalls, are commonly seen in the mountains, but on the plains the water flows almost at grade with only occasional rapids. In the Alps the rivers usually flow in open U-shaped valleys, with steep rock slopes on either side. Generally too the ends of the few spurs which are prolonged from the bounding ridges are truncated. On the plains the rivers meander in numerous and ever-changing courses across spacious gravel flats. Floods are everywhere common, since not infrequently the bed of a river is above that of the level of the surrounding country.

In the mountains the Westland rivers in many ways resemble those of the eastern side, but in general the valleys are narrower, though still U-shaped. Gorges are more frequent, and the river channels are more clogged by huge boulders. On the flats the dense forest growth may prevent to some extent the spreading of the river-bed, which is so evident on the eastern side of the Alps.

In the South Island much the largest river is the Molyneux or Clutha; a fine stream about one hundred and fifty-four miles long,* which rises in several large lakes amid the various subsidiary ranges of the Alps in the southern part of the island. In its headwaters the river valley shows graphic evidence of past glaciation, but lower down the river flows mostly in great bends with occasional gorges. As it nears its embouchure the stream assumes the characteristics of the

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* As measured from Lake Wanaka to its mouth.

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normal Canterbury Plains drainage. The gravels of the Clutha, as well as those of many of the Westland rivers, carry much alluvial gold.

The Buller is the largest stream flowing to the west coast of the South Island. Its principal tributaries rise on the slopes of the Spencer and St. Arnaud mountains. Though the river shows many fine stretches of calm deep water, the occasional rapids prevent its navigation by steamers, in fact none of the rivers of the South Island is navigable for steamers, save for comparatively short distances.

In the North Island the two largest rivers are the Wanganui and the Waikato. Small steamers ply up and down both streams for some distance from their mouths. The Wanganui rises on the western slope of the volcanoes of Ngauruhoe and Ruapehu and flows with gentle gradient down the slope of the Wanganui Coastal Plain.

The Waikato rises on the eastern slopes of Ngauruhoe and Ruapehu, and presents from its source to its mouth in Kawhia Inlet a great variety of scenery. Not far from its headwaters is Lake Taupo, an expansive body of water some sixteen miles wide and about twenty-five miles long. Numerous Maori settlements surround its shores, and many were the Maori battles which occurred here in the fighting days of olden times. About seven miles below Lake Taupo the course of the river is broken by the beautiful Huka Falls and a short distance lower down by the Aratiatia Rapids. These falls and rapids mark where the river is cutting through the volcanic flows which aided in the damming back of Lake Taupo. In the lower reaches the Waikato is a fine broad river flowing smoothly in great bends and bordered by the flat lands of the Waikato Plain.

GLACIERS.

If we except the small ice rivers on Mt. Ruapehu, glaciers in New Zealand are confined to the Southern Island. They fill the heads of many alpine valleys from Arthur's Pass southward and in the heart of the Southern Alps, in the neighborhood of Mt. Cook, form ice rivers of imposing proportions. In this locality the Tasman, Murchison, Hooker and Mueller are the principal glaciers descending on the eastern side of the Alps, while the Franz Josef,

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Steam Clouds Rising from Waimangu. (Photo by New Zealand Tourist Department.)

Rapids Above Huka Falls, Waikato River. (Photo by New Zealand Tourist Department.)

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Fox, Balfour, Douglas and McKerrow are the largest ice streams flowing towards the western seaboard.

If the Tasman and Franz Josef glaciers—the snowfields at the head of each interlock—be described, the most salient features of the glaciers on either side and the contrast between them will be apparent. The Tasman is a magnificent glacier some eighteen miles long and about two to three miles in width where widest. The glacier rises in numerous small snowfields which descend in much broken icefalls to a spacious cirque at the base of Hochstetter Dome, Mt. Elie de Beaumont, Mt. Darwin and other lofty peaks. Though broken by numerous crevasses, which increase in number toward the frontal face, the surface of the glacier is not really rough and it descends practically at grade, being joined by several steeply flowing glaciers, especially on the western side. The surface of the glacier for the last five or six miles of its source is thickly cloaked with morainic débris. The frontal face stands at an altitude of 2,354 feet and the average rate of flow of the ice in the lower part of the glacier is probably under one foot per day. Steep slopes scantily clad in scrubby vegetation, diversified by immense scree slides, border the glacier near the frontal face. Below the glacier the broad Tasman Valley for more than forty miles is straight and open, and shows how vast must have been the great glacier which in Pliocene or early Pleistocene times flowed seaward and deployed on the plains beyond the mountains.

Unlike the Tasman, the Franz Josef rises in relatively spacious snowfields, the ice-flows from which unite and descend thousands of feet in one great icefall. Below several small glaciers join with much séraced ice, and the main glacier, with almost everywhere much broken ice, descends practically as a continuous ice rapid. From the névé at the head of the glacier, rise the Minarets, Mt. de la Beche and other stately alpine peaks, but their apparent magnitude is much depreciated by the relatively great height of the snowfields themselves. The glacier is about eight and one-half miles long and where widest is about half a mile in width. Its surface is almost entirely free from moraine. The steep rock slopes immediately joining the ice in many places and the several roches moutonnées near the frontal face are well smoothed and striated. At present the frontal face of the Franz Josef stands some twelve or thirteen miles from the sea in a direct line, though formerly it extended much farther seaward and united with many other glaciers to the north and south to form a great ice sheet. Within the last few years the glacier has made a marked advance, but this is supposed to represent merely a temporary invasion of the valley, rather than a secular forward movement. The rate of flow of the Franz Josef Glacier is much more rapid than that of the Tasman; rates as high as sixteen feet per diem being noted in places. The frontal face stands as low as 692 feet above the sea. As Dr. Von Hochstetter, the Austrian geologist, years ago remarked, one would have to travel in Scandinavia as far north as the latitude of 67° before seeing a glacier of such magnitude descend to so low an altitude. The low level reached by the Franz Josef Glacier is due mainly to the steepness of its grade in descending from such large snowfields, though everywhere in the Southern Alps the snowline is more depressed than would be expected in latitudes so close to the equator. This depression of the level of permanent snow is due to the immense precipitation produced by mountains disposed at right angles to the prevailing moisture-laden winds. The climate is remarkably mild, but the summers are somewhat cooler than would be expected in such latitudes.

It would be difficult to imagine a grander spectacle than that presented by the Franz Josef Glacier. For miles from its terminal face and for thousands of feet up the steep bordering slopes grows a vegetation almost subtropical in luxuriance. The contrasts of the *ensemble* are marvelous. From beneath the shade of a fern one may look down on the blue and green much crevassed ice; may scan the brilliant forest, gay in summer with blood-red flowers of the rata; or may gaze upon gray rock precipices rising to mighty peaks, surrounded by perpetual snowfields. In the forest gaily colored pigeons and sprightly fantails flit among the branches, while now and then chattering parrots (*Nestor notabilis*), strangely out of keeping with their icy surroundings, will flutter down on the glacier.

Perhaps the most remarkable glacier in the Southern Alps is the Douglas, situated some twenty-two miles (airline) to the southwest of the Franz Josef, and, like it, on the western side of the Alps. The glacier consists of two distinct parts, the névé and the trunk portion or glacier proper, separated by a precipice of gigantic proportions. This precipice, which is over 2,000 feet in height, exhibits in the upper 1,000 feet an icefall of stately magnificence, while the lower part is an almost vertical face of rock. The névé of the glacier may be considered as a cliff glacier on a big scale, while the trunk portion formed by the union of innumerable avalanches, which at the rate of thirty miles an hour cannonade with deafening roar over the great precipice, is a typical valley glacier of the reconstructed type.

LAKES.

Like most countries where extensive glaciation has occurred, and where there have been recent faulting and volcanic activity, New Zealand contains many lakes. In the North Island most of the inland lakes are directly or indirectly due to volcanic agencies. Thus the great lake of Taupo seems to have originated by the bodily subsidence of a large area of volcanic rocks, owing to the removal by long-continued vulcanism subjacent to the earth's actual crust. Most of this material was expelled from the volcanic vents in the form of pumice and ash. Possibly its area may have been enlarged or even its initial basin originated by the damming of the outflowing river (now the Waikato) by a lava flow.

Lakes Rotorua, Rotoiti, Rotoehu and Tarawera, are seemingly the result of the same causes as those that formed and developed Lake Taupo. Lake Rotomahana is a sheet of dirty, muddy, green water some three and one-half miles long by less than two miles in width, and with a maximum depth of 427 feet. The lake occupies an immense crater that developed at the time of the Tarawera eruption in 1886 on the site of a small preëxisting lake. At the northwestern corner the temperature of the water of the lake is so high that it is continually steaming.

The shallow lake, Omapere, in the North Auckland Peninsula was formed by the damming of a mature, well-graded valley by a recent lava flow.

The small lakes around the slopes of Ngauruhoe occupy old craters.

In the South Island the lakes are due mainly to past glaciation, though tectonic movements seem originally to have influenced the form of some of the valleys in which the larger lakes lie. A number of the smaller lakes, such as the beautiful Ianthe and Mapourika in Westland, are merely irregular depressions in the sheet of morainic drift. Again many of the small tarns high up in the alpine valleys fill ice-gouged basins. Moraine dams across a valley—probably preëxisting before glaciation but markedly influenced by that action, have mainly caused the larger lakes. Of this nature is the beautiful Lake Kanieri, surrounded by splendid unbroken forests, with the lofty peaks of the Alps in the southern and eastern background.

Lake Coleridge, Lake Pukaki and others on the eastern side of the Alps fill the plainward extremities of U-shaped valleys, in whose head glaciers are still active. Lake Wakatipu, farther to the south, and lying in almost the center of the mountainous country, occupies a basin which was apparently formed originally by diastrophic movements, later modified by glaciation.

The splendid surrounding forests and the matchless background of gigantic rock precipices or snow-clad alpine peaks render the scenery of Lake Manapouri and Lake Te Anau to the south of Lake Wakatipu the most impressive in New Zealand.

Lake Ellesmere in the South Island, Lake Wairarapa in the North Island and others occupy old arms of the sea into which freshwater streams flow. As their mouths became bar-bound, the salt water was cut off and the water of the basins freshened. Correctly speaking they are lagoons, and frequently when their outlets become dammed during stormy weather, a channel for their waters must be excavated artificially in order to prevent the surrounding country from being flooded.

THE SHORELINE.

The shoreline of New Zealand has seen many oscillations in level through the long geological ages. These changes have continued into recent times and doubtless are still proceeding. Thus the demarcation between sea and land is markedly varied, and in many places intricate.

In the North Auckland Peninsula the depressed river mouths, the numerous skerries and islets off the coast, and many other features testify to the recent depression of the land. Thus have been produced the beautiful harbors of Whangaroa, Bay of Islands, Whangarei and Auckland. The first named is a perfect shelter, its narrow entrance, its interior spacious accommodation joining to make a thoroughly safe anchorage for ships. From a scenic standpoint the mural precipices that border the calm water in many places and the varied vegetation give it great charm.

South of the Coromandel Peninsula, the eastern seaboard of the North Island, mainly cut in soft rocks, is bordered for miles by marine-eroded cliffs, varied by long sand or gravel beaches with sand dunes. With the exception of Tauranga and the artificial port of Napier, the harbors are open bays. Elevated beaches on the coast near Waihi certify to recent upward movement.

The western seaboard resembles in many ways the eastern side. Cliffs cut in the soft strata of the Wanganui Coastal Plain are barred by sandy or gravel beaches, from which sand dunes sweep inland in places over the surrounding low country. The southern part of the North Island seems to have been depressed in comparatively recent times, but the last movement was certainly upward. Graphic evidence of this uplift is seen in and around the harbor of Wellington. This harbor originated by the depression of a basin primarily formed by tectonic subsidence, but apparently much influenced by fluviatile erosion. At the time of the great earthquake in 1855 the shoreline around the harbor and apparently for many miles along the shores of Cook Strait was elevated some five feet. Thus New Zealanders owe part of the very limited flat land on which their capital city is built as well as the fine natural road which follows the sea beach from Lyell Bay to Worser Bay to this seismic event.

The northeastern part of the South Island exhibits a multiplicity of bays, channels and islands, with a wild rocky shoreline; while towards the northwest onward from the city of Nelson, low shores broken by low cliffs vary for the greatest length of the coast the bolder topography. Harbors to the northeast are common, but toward the northwest, if we except the semi-artificial harbor of Nelson, only such as exist behind ever-changing sand-bars are seen. Both the eastern and western shores of the South Island show long stretches of gravel and sand beach, broken by low cliffs and inconspicuous headlands. On the west coast, north of the almost uninhabited fiord region, almost the only harbors are behind the bars of the numerous large rivers. Crafts not infrequently come to grief trying to enter these dangerous and changing channels. The difficulties of working such ports account in great part for the high price of coal in New Zealand, which is derived mainly from mines on this storm-bound coast.

On the eastern coast the best harbors are formed by ancient craters or depressed valleys in the hard volcanic rocks of Banks Peninsula.

Raised beaches on both the east and west coasts show recent elevation. Otago Harbor, on which is situated the city of Dunedin, is the result of the depression of two adjoining stream valleys excavated in volcanic rocks.

The whole of the southwestern part of the South Island shows a subsidence of the land. Here the numerous sounds or fiords formed by the depression of old glacier valleys are features of great scientific interest. The sounds are generally narrow, or relatively narrow, and are bordered for the most part by steep much smoothed rock slopes. The water is remarkably deep, though shallower parts occur at the entrances of all of them. The best known sound, Milford, is a feature of great beauty. Steep precipices rise thousands of feet from the water's edge or from the borders of the few gravel flats. A scant vegetation clings to the steep slopes, while the rare flats are covered by a luxuriant and varied forest. In places waterfalls leap many hundreds of feet from high hanging valleys, while everywhere in the background rise snow-clad peaks and here and there high perched glaciers stand out against the lower gray mountain sides.

THE COMMERCIAL GEOGRAPHY OF NEW ZEALAND.

P. MARSHALL.

At present the inhabitants of New Zealand number a little more than a million people. This small population is naturally unable to specialize in the industries to a sufficient extent to supply all the multifarious wants of a civilized race of the twentieth century. This would still be the case even if all the raw material necessary for the preparation of the various commodities that are required could be obtained in the land. So many and diverse are these objects which have to be brought from other countries that statistics show that goods to the value of £16 per head of the population are annually imported. It is obvious that in a country whose inhabitants have little capital invested elsewhere there must be at least as much material exported in order that the people may be able to pay for the commodities which they import. It is found that the annual amount exported amounts to a value of £20 per head.

These statements evidently mean that the trade of New Zealand with other countries is considerable and it is well to realize the geographical position of the islands and the advantages or disadvantages that their inhabitants have in their efforts to exchange goods with other lands.

Physically New Zealand is much isolated, for 1,200 miles of rough ocean waters separate her from the nearest land. Considerable as this isolation is, it is small compared with the commercial isolation, since it happens that Australia, the nearest land, produces much the same commodities as New Zealand and therefore has use for very little of her products. Even those substances which in the cooler and moister climate of New Zealand can be produced more readily than in Australia are largely debarred by reason of the high protective tariff that is imposed by the commonwealth on all commodities which can be produced within her boundaries. The other continents that border the Pacific Ocean are almost as unsatisfactory from a commercial standpoint. The great United States of America with its eighty millions of inhabitants opposes a protective barrier to the exports of New Zealand which is so high as to be almost prohibitive. Eastern Asia with its teeming millions wants but little of wool or meat which form the most important exports. South America with its sparse population produces practically all those substances that New Zealand exports and the same condition applies to South Africa. Thus all the lands that are geographically close are almost closed to the articles which are exported from New Zealand. It is to Europe and more particularly to Britain that nearly all the products of New Zealand have to go. Situated 12,000 miles away from this market she has to compete with Australia 1,200 miles less distant and with the Argentine Republic of South America and with South Africa which are each about 7,500 miles away from Great Britain. Thus handicapped by the accidents of geography New Zealand requires some compensating advantage in order that she may be able to retain her position in a market in which she has rivals so large, powerful and enterprising. The compensations are to be found in the productiveness of the soil, and the reliable nature of the climate, which is free from extremes of heat and cold, from devastating flood and blasting drought. The stable nature of British political institutions and the effect of the climate in stimulating the energy of British people are other factors giving a compensation that in part reduces the great effect of geographical position, which otherwise might be overpowering.

Distribution of the Population.—Here as in all other countries the people are not distributed evenly over the land. One cause of this is to be found in the early history of colonization. The native ownership of land has always been recognized, and almost all the land now held by Europeans has been purchased from the natives. The government has usually been the purchaser, but the process of buying has been slow, and blocks of a sufficient area to provide for all their probable descendants, have in all cases been reserved for the natives. The native owners are often averse to selling, and when they do wish to sell it is a difficult matter to find the owner or rather to find out the proper share of the purchase money that should be given to the many individuals of the selling tribe, for the Maoris held all property in common. There are still large areas of fertile land, especially in the North Island, which are held by native owners and are lying almost waste. Other causes of the uneven dis-

Wheat Fields, Canterbury, New Zealand. (Photo by New Zealand Tourist Department.)

The Shipping, Wellington Harbor, New Zealand.

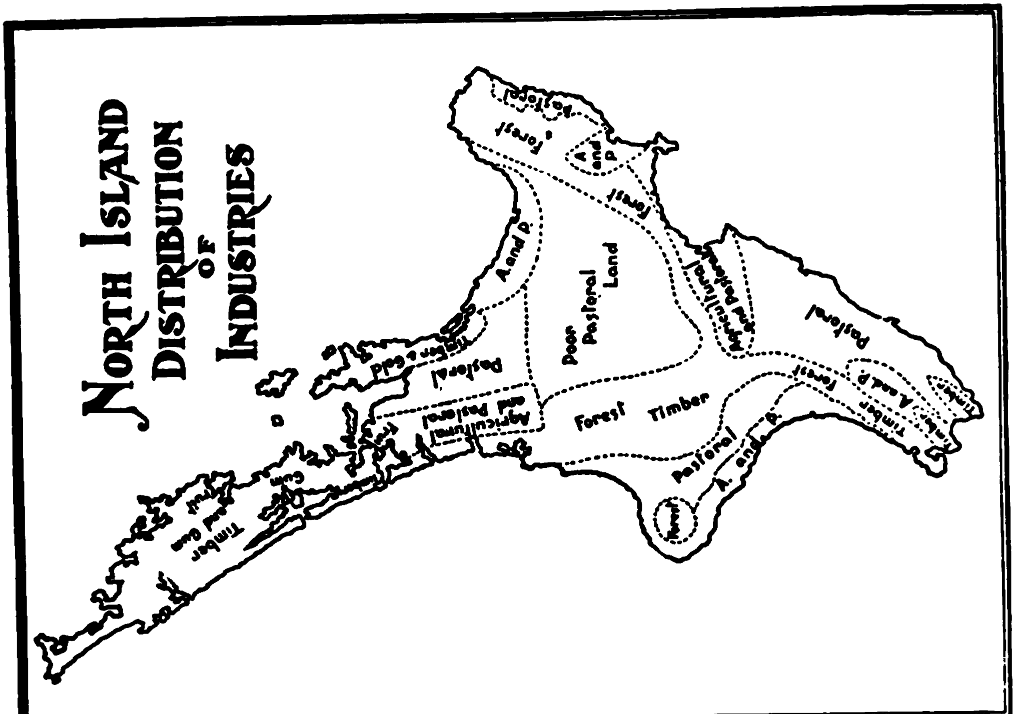
tribution of the population are to be found in the rough and mountainous nature of part of the land, especially in the South Island, where a large area consists of high mountain tops separated by deep cleft-like valleys and is inhabited by a few shepherds only, who look after the sheep over a great expanse of broken country. In the South Island on the western lowland bordering the foot of the Southern Alps the climate is so wet as to present great obstacles to the clearing and burning of the forest growth which covers the land with an impenetrable tangle. Some districts, apart from those that are mountainous, are not sufficiently fertile to allow close occupation. This is the case throughout the extent of the great pumice plateau which covers the greater part of the interior of the North Island, while in the peninsula that lies to the north of Auckland there is a considerable stretch of clay soil which it has hitherto been found impossible to cultivate with profitable results, though it is known that much of it is extremely suitable for fruit growing. Some of the country is not yet supplied with roads, let alone railways, and the expense of bringing the products of such land to market prevents it from being closely occupied. In the extreme southwest there are a few patches of country of a rugged and picturesque nature which have not yet even been explored.

The eastern plains of Canterbury are more thickly populated than any other part of the country. The plains of Southland and the coastal lands with some patches in Nelson and Marlborough are other districts that support a fairly dense population. In the North Island the land stretching north from Wellington on both sides of the central mountain ridge is thickly populated as far north as Napier on the eastern side and thirty miles to the north of New Plymouth on the western side. Much of the Waikato is closely settled, and in the immediate neighborhood of Auckland there is a large population, while further north the few closely settled districts are small and far apart.

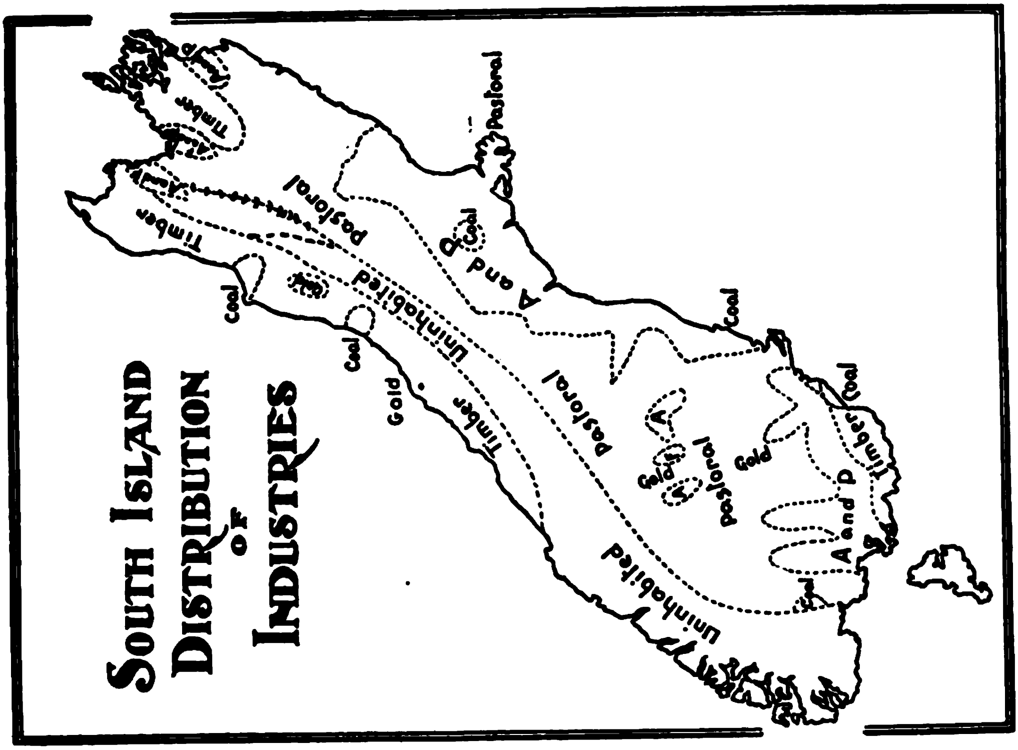
A satisfactory feature of the distribution of the people of New Zealand is that there are four relatively large centers of population not very different in size. This to some extent reduces the tendency which is so noticeable in many countries for the people to aggregate in the populous centers to the neglect of the more outlying parts of the country.

Land Tenure.—The greater part of the settled land of the country is held on the freehold system. Of late years however the government has bought out several of the large estates and divided them into small farms which are occupied by state tenants who, at the present time, have not the right to purchase. There is also a graduated land tax which practically prevents the aggregation of large estates.

Industries.—The pastoral industry at the present time entirely surpasses all others in importance. This is only natural, for the hilly nature of a large part of the country makes it eminently suitable for the healthy growth of flocks of sheep. The twenty million sheep that there were in the country in 1908 produced wool to the value of £6,800,000. The number of sheep in each of the two islands is almost equal. Of late years sheep have not gained in number though the amount of available land increases year by year. This is due to the great advance of the dairying industry, especially in the North Island, for this yields more profitable returns than sheep farming and many of the small farmers have now adopted dairying in preference to sheep rearing. In consequence of this advance of the dairying industry the number of cattle has greatly increased of late years. In 1908 the cattle numbered 1,800,000 and of these as much as 76 per cent. were in the North Island. There were a little more than 600,000 dairy cows, and of these 72 per cent. were in the North Island. The center of the dairying industry is the Taranaki Province where the output of butter amounts to more than 7,000 tons annually. In this connection the neighboring province of Wellington is second in importance and Auckland is third. In the northern part of the South Island the industry is of very small dimensions but increases in importance towards the south and is most extensive in the southern province of Otago. The total value of the cheese and butter over and above that required for local use is nearly £2,000,000. In addition it is estimated that 8,000 tons of butter were used in the country. From these returns it has been calculated that the average amount obtained from each cow in the herds of the country amounts to 163 pounds of butter. Such a high result obtained from herds that are not specially cared for speaks well for the productive nature of the soil and the general mildness of the climate.



(From Marshall's "Geography of New Zealand.")



(From Marshall's "Geography of New Zealand.")

The source of the sheep and cattle of New Zealand is to be sought mainly in the flocks and herds of England, though from time to time some prize stock has been obtained in Australia. A great many breeds of sheep are represented. Merinos were for a long time much favored, especially in the South Island, but now cross-breeds of many types are more common. This change in the type of sheep has been due mainly to the growth of the important frozen meat industry, for the cross-breeds, besides producing a serviceable fleece of fair weight, mature early and can soon be put on the market as frozen meat. No less than four and a quarter million frozen carcasses were exported in 1907 and the farmers gained thereby to the extent of nearly three million pounds. These figures show how vitally important the pastoral industry is to the country, for the value of the exports of wool, dairy produce and frozen meat together amount to £11,500,000. The frozen meat industry was commenced only in 1883; it grew very rapidly, but for the last five years it has been almost stationary. It is certainly romantic to reflect that some of the mutton which appears on the dinner table in London was grown on the New Zealand mountains more than ten thousand miles away.

Agriculture in New Zealand is far less important than the pastoral industry. The cereals that are grown are in many years not produced in greater amount than is required for home consumption and little or none is left over for export. This is partly to be attributed to the climate, but more to the uneven nature of the surface and to the soil, for these are seldom adapted for the growing of wheat. For both wheat and oats the Canterbury Plains are the most prolific locality, nearly three quarters of the wheat and half of the oats being grown there, whilst most of the remainder is grown in Otago. Relatively little of either of these cereals is grown in the North Island, though it is probable that there will be an increase when the stumps of the forest trees have been removed from some of the land that was originally covered with heavy forest and is at present pasture land. Of other cereals a little barley is produced in various parts of the South Island and a small amount of maize in the Auckland district.

Mining.—The mineral wealth of New Zealand is considerable, and the mining industry is responsible for a large proportion of the

The Great Waibi Mines, Auckland, New Zealand.

Hartley and Riley Gold Dredge, Clutha River, Otago, New Zealand.

prosperity of the Dominion. It was in fact in some measure the cause of the rapid advance of the country in the early period of colonization. The rich alluvial fields of Otago were discovered in the sixties of the last century and attracted a feverish rush of gold miners from Australia and California. As is usual in alluvial gold fields the rich patches were relatively few and many of the miners left the country, but a few remained and in some cases took to less exciting occupations. In 1866 the yield of gold was worth nearly three million pounds but later on it decreased considerably and in 1890 was only three quarters of a million pounds in value. Since then there has been a great advance and in 1906 the yield was worth more than two and a quarter million pounds. This revival has been due mainly to the application of the cyanide process of gold extraction. At the same time in the alluvial fields of Otago much gold that had previously lain submerged beneath the gravels of rivers was recovered by the use of dredges.

It is in the Cape Colville gold mining region in particular that the effect of the introduction of the cyanide process is most clearly seen. The great Waihi mine which now produces more than £900,000 of metal annually was not a paying concern when amalgamation processes of gold extraction were employed. Now the £1 shares are worth nearly ten pounds. The bullion obtained in this mine contains six ounces of silver for every ounce of gold. A similar excess of silver over gold obtains in many other mines of the Thames-Hauraki gold field. This most prolific gold mining area of New Zealand is situated in an old volcanic district and it is supposed that the deposition of the gold has been associated with some of the later volcanic activities of the district, such as the ascent of hot springs from the heated rocks below. Another quartz mining region is Reefton on the western side of the South Island, but it has little importance compared with the Thames-Hauraki field.

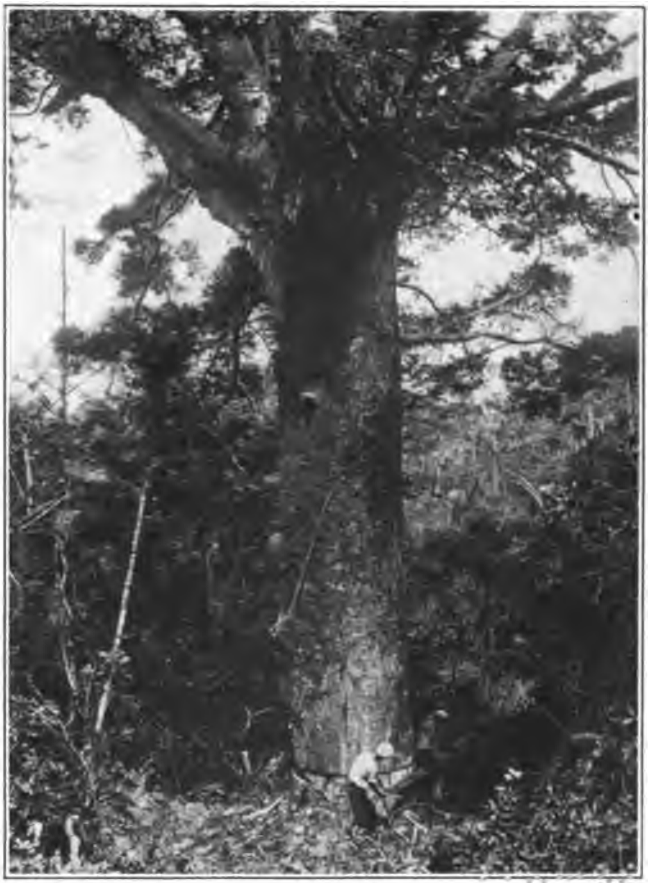
Most of the alluvial gold is obtained from the recent gravels of the Clutha River and its branches in Otago, where the gold in the waste resulting from the destruction of a great thickness of schist rock has been gradually concentrated by steam action. Other alluvial grounds are in Westland, with Hokitika as a center. The amount of gold obtained from alluvial workings is slowly decreasing, though a few years ago when the dredging method was applied to some of the river beds the industry received a great spurt.

The total value of the gold that has been won from the rocks of New Zealand is now £83,500,000.

There are several coal mining districts but from most of them brown coal is produced. There is, however, a coal field on the west coast of the South Island with its center at Westport from which coal of an extremely valuable type is obtained. This coal is "bituminous" and of great standing as a steam producer. More than a million tons of this coal are mined annually and the greater part of it is consumed within the dominion. It is also largely in demand for use on the steamers that trade between New Zealand and other countries. The coal and gold mining industries are in a large manner responsible for the settlement of the west coast of the South Island, for the mountain sides clothed everywhere with dense semi-tropical vegetation offer in the wet climate so much discouragement to farming that but few settlers, even the most resolute and enterprising, would have undertaken the task of opening up what was a wild and forbidding district had not nature provided a great compensation in the remarkable mineral wealth stored there. The brown coal districts are for the most part situated on the eastern side of the country, especially in the South Island. Between the mouth of the Clutha River and Christchurch there are dozens of mines, but the output of all is relatively small as judged by American standards. The coal from these mines is used largely for local household and steaming purposes, but there is no outside market. In the North Island similar coals are found at Whangarei a little to the north and at Huntly a little to the south of Auckland, and from these the city of Auckland draws its supplies. There are other mines of a similar coal near New Plymouth, but this too has a purely local use. Altogether not more than 700,000 tons of this class of coal are produced annually.

Very little mineral oil has been obtained from New Zealand rocks up to the present time. Attempts have been made to obtain this material at various places where indications are favorable, but it is only at New Plymouth that these have at present achieved any great measure of success.

Other geological deposits of economic value have been found in



A KAURI TREE, AUCKLAND, NEW ZEALAND.

very small amount only; thus there had been no lead or zinc mining, and the amount of copper that has been produced is quite a small quantity, though some has been mined at Nelson and, many years ago, at Kawau Island near Auckland.

Iron ores are not mined, though a large deposit of limonitic ores has lately been thoroughly surveyed by Dr. Bell at Parapara near Nelson. A little chromite has been mined in the past near Nelson but none is produced now. Rather an unusual mineral production is found in the scheelite ore which is produced in Otago but the amount exported is small—in fact less than 150 tons each year. A still more unusual material is the kauri gum. This is a resinous exudation from the root and trunk of a magnificent coniferous tree which must have grown in the past over large tracts of land that are now treeless and regarded as barren country. Though many of the gum fields are now practically exhausted the amount annually exported is still considerable and its value over half a million pounds. The gum is a hard yellow substance like amber but more brittle. It is always found in quite shallow workings in clay soil or swamps and the actual lumps are often discovered by piercing the clay with sharp pointed iron spears. Prospecting by "spearing," however, is not now so much practiced as in former years. Some phosphate rock is mined near Dunedin and is largely used for agricultural purposes within the dominion.

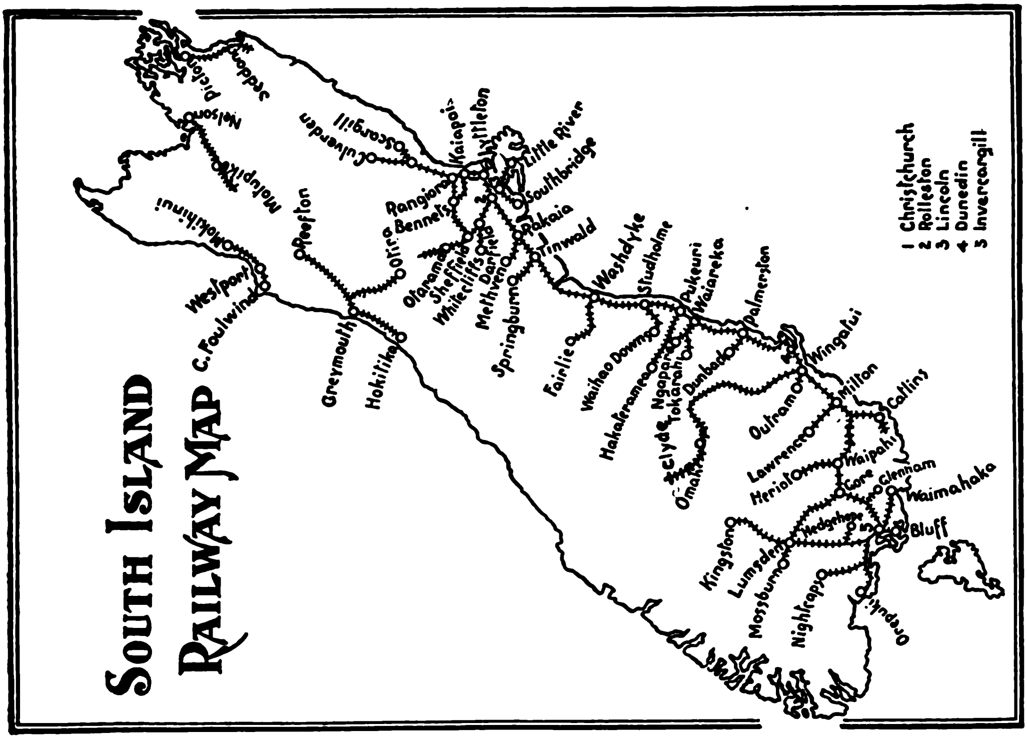
Fruit Growing.—Though New Zealand is blessed with a temperate climate suitable almost everywhere for the growth of most European fruits very little has hitherto been done in the way of systematic fruit culture. Most of the fruit that is consumed in the country is locally produced, but the distance of other markets has prevented fruit from being grown for export. The inland districts of Otago, where the winters are often severe and the summers hot, and the Auckland clay lands grow excellent fruit. On the alluvial lands near Napier and Nelson somewhat extensive orchards are now being planted.

Timber.—The giant kauri tree has always excited much interest. The column-shaped trunk which sometimes attains a diameter of twenty feet is always perfectly cylindrical and often free from branches to a height of eighty feet from the ground. From the top of this majestic column is given off a crown of massive twisted branches which bear a relatively small amount of foliage. The timber sawn from this monarch of the New Zealand forest is of excellent quality, but unfortunately the tree grows in a limited area only, and over a great part of this all the available timber has already been felled. The kauri is confined to the northern portion of the Auckland province and does not grow south of 39° south latitude. Hilly country is the home of the kauri and in the thick growing New Zealand forest much difficulty is encountered in getting the logs to the saw mill. Usually they are simply jacked into the nearest stream and lie there until a flood fills the stream sufficiently to float the logs out. The logs may lie in the stream bed as much as twenty years before a flood washes them out to the booms at the river entrances.

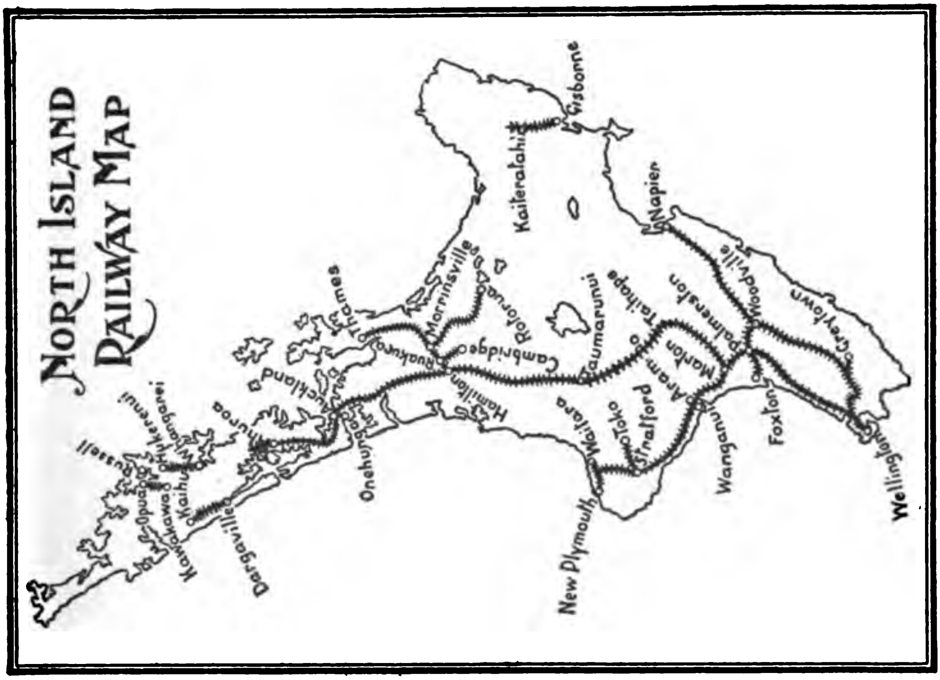
The other forest trees of the dominion yield a class of timber that is inferior to that of the kauri in some important respects. They are however much used in local buildings and for general purposes. Most of the timber trees are conifers, though in the south a little beech timber is milled. So high is the cost of producing New Zealand timber that of late years it has been found profitable to import Oregon (Douglas) pine from America.

Fishing.—An abundance of good fish can be obtained in the coastal waters and the local markets are always kept fully supplied. A moderate amount is exported in the frozen state to Australia from the southern districts of the dominion. A few whaling stations still exist on the coast, but it appears that the great whaling fleets of earlier days permanently reduced the numbers of whales in these seas.

Manufactures.—The wants of such a small community as a million people do not allow of a great specialization of factories. The relatively high price of labor and the remoteness of New Zealand from outside markets prevent the establishment of factories for the production of commodities for export. Those factories that do exist are almost entirely concerned with the production of staple substances for use within the dominion and with the construction of those objects that are required for the important industries. Another important class of works is connected with the simple preparation in forms suitable for export of some of the agricultural and other products. Thus meat freezing works, butter factories



(From Marshall's "Geography of New Zealand.")



(From Marshall's "Geography of New Zealand.")

and tanneries produce a large amount of material for foreign markets. The grain mills, engineering shops, woollen and clothing works supply the cereal foods, implements and garments required by the population.

Trade.—The mountainous nature of a large portion of the country has greatly hindered the construction of a complete railway system. The want of this, however, has been felt less severely because of the great length of the coast line and the consequent easy communication by water. Nevertheless, railway construction has made steady progress and there are now 2,700 miles of railway track in operation. The greater part of the railways is comparatively close to the coast, but the opening of the North Island trunk railway at the end of 1908 connected Auckland and Wellington by a track that passes through the center of the island. The vigorous construction of roads has brought most parts of the country into close connection with the railway and the settlers can now in most cases bring their produce to the coast with moderate ease and cheapness. There are, however, important districts of the country, especially in the North Island, that still require opening. As soon as the land is bought from the native owners efforts are made to road it and as the settlers increase in numbers the demand for a railway is before long met. Progress has been slow, for the dense nature of the forest that at first covered much of the land required the application of much energy and perseverance before it could be felled and the forest waste could be converted into smiling pasture. Even then the uneven nature of the country, and the frequent absence of suitable road-forming material over large areas have presented formidable obstacles to rapid development. The system of telegraphic and telephonic communication is fairly complete and almost every little hamlet is connected with one of the larger centers. This facility of communication is still further increased by an excellent postal system, by which mails are carried regularly throughout the country.

External Trade.—There are many excellent deep-water ports, but it is unfortunately the case that they are often situated far from the areas of dense settlement and are in many cases shut off from them by tracts of mountainous land. It thus happens that some marine inlets which are by nature inferior have by artificial means been converted into harbors capable of accommodating the large ocean-going vessels that now convey the produce of the country to the over-sea markets. The harbors of Auckland and Wellington are deep, easy of access and large enough to accommodate huge fleets. Those of Lyttelton and Dunedin, which serve the larger part of the South Island, are relatively inferior and in the case of the last at least have to be constantly deepened by dredging operations. The wide and extensive natural harbors of the Queen Charlotte Sounds are of little use as they are not in communication with any considerable areas of productive country. This is still more true of the magnificent fiords of the extreme southwest which are to-day almost in the same condition of isolated loneliness as when discovered by Captain Cook more than a century ago. The main ports are well equipped with wharves and appliances. Thus vessels can always get rapid discharge, and can be speedily loaded.

Except in the extreme south the harbors of the west coast are obstructed with bars of drift sand which the prevailing current and sea constantly wash along the coast. This is a severe hindrance to the navigation of the coal ports on that coast, though the construction of harbor works has reduced the difficulty to a considerable extent. Still the water on the bars is relatively shallow and the ports can be visited regularly only by vessels of quite small draught.

From the four larger ports, Auckland, Wellington, Lyttelton and Dunedin, there is regular and frequent communication with Australia and England and less frequently with other countries. The Union Steamship Company, locally controlled, carries the greater part of the Australian trade, but the trade with England is carried in the steamers of companies that have their headquarters in England.

Out of a total export of goods valued at twenty million pounds as much as sixteen and a half goes to England and of the remainder other British possessions take products valued at two and a half millions while foreign countries take less than a million pounds worth. The steamship lines that provide the vessels to carry these exports naturally furnish large steamers which can be relied on to perform the passages with safety and punctuality. Provided with freezing and cooling chambers they regularly land the perishable products of New Zealand industry in a condition that satisfies the

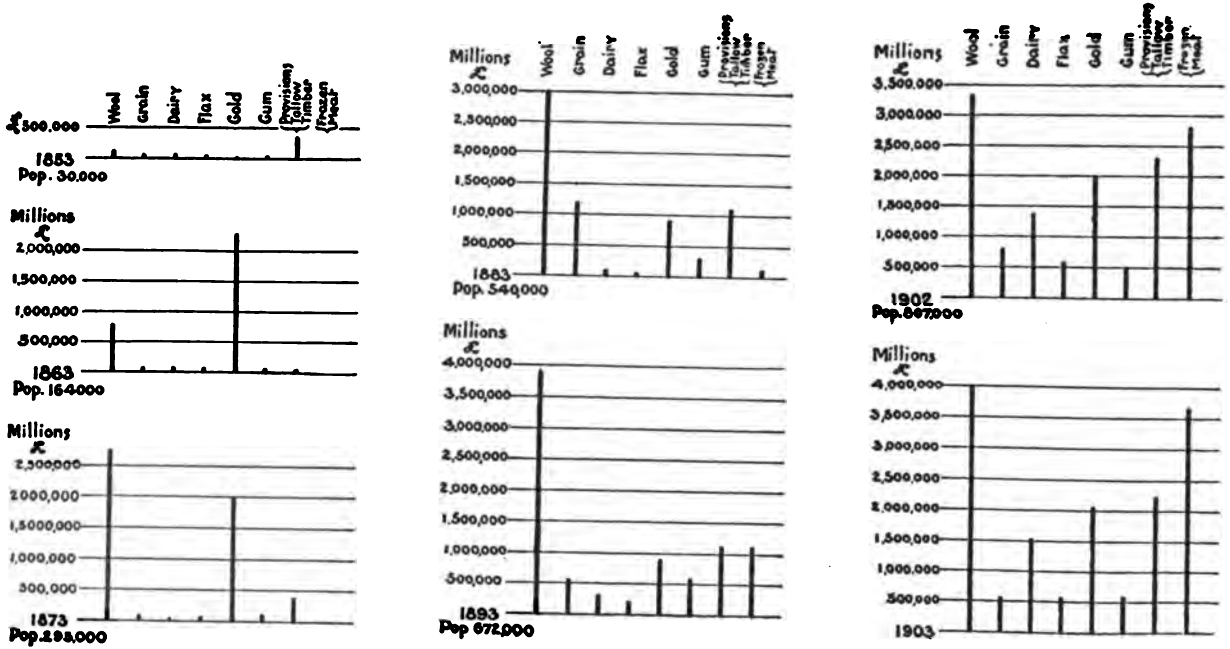


DIAGRAM SHOWING VALUE OF CHIEF COMMODITIES EXPORTED FROM NEW ZEALAND FROM 1853 TO THE PRESENT TIME.
(From Marshall's "Geography of New Zealand.")

exacting requirements of the London market. A noticeable factor in achieving the latter result has been the government system of inspection and grading by which the quality of the exports is guaranteed.

The imports into the country were in 1907 only some seventeen million pounds in value. Those imports that came from England were worth ten millions while the material imported from other British possessions were worth four and a half millions. From foreign countries the imports were worth more than two millions, and of this value about half came from the United States of America. The imports from foreign countries have shown little advance since 1901 at which date a preferential tariff in favor of British goods was instituted.

The rapid development of New Zealand has required a great expenditure of money and it was impossible that this expenditure should have been met by employing the resources of the dominion herself. Throughout the period of advance it has been found necessary to borrow money for the construction of public works and the purchase of land as well as the organization of the public services. The money that has been borrowed for these purposes is a large sum and now amounts to a public debt of £71 per head of the population. The burden of paying the interest on this large sum is cheerfully borne for it is recognized that the greater part of the money has been expended in the construction of public works and railways, and in other similar objects of national importance and that these directly or indirectly earn the interest that is paid for the borrowed money.

The Future.—Endowed with a temperate and invigorating climate, a fertile soil and the stable institutions of British system of government, New Zealand, there is every reason to believe, will continue to produce commodities as successfully in the future as in the past. There is still a large area of land waiting for occupation, and as this is gradually settled the output of farming produce will increase. Manufacturing industries may yet flourish, for in all parts of the land there is an abundance of water power running to waste and the utilization of it has only just commenced. Iron and steel works may arise and the complex demands of a modern civilized community may be met by the establishment of industries the products of which will be demanded by an increased population.

GEOGRAPHICAL NEWS AND NOTES.

The new series of bathy-orographical wall maps, published by W. & A. K. Johnstone, includes a separate map of each of the continents, the principal oceans and their borderlands, the world as a whole, and detailed maps of the British Isles and the basin of the Thames. As samples of the map maker's art the individual maps are equal to the best that the German cartographers have done and the series is far superior to any others for general class room work. It is an open question, however, whether the selection of color schemes is entirely logical and the best available. For example in indicating the depths of the oceans increasing intensity of color shows increasing depth. On the other hand, in indicating the relief of the lands the lightest color is for intermediate altitudes, with heavier shades for levels both above and below. The colors used are pleasing in their effect, but it is the belief of the writer that the same order of successive gradations of intensity of color could be used more satisfactorily for both oceanic and continental relief.

The *Scottish Geographical Journal* gives some details in regard to Captain Scott's proposed Antarctic expedition. The main object would be to attempt to reach the pole, and with this object two bases would be established, one at McMurdo Sound, and one if possible in King Edward VII. Land. The attack on the pole would be made from one or other of these bases according to circumstances. Three separate means of traction would be employed—ponies, dogs and motor-sledges. The experience gained by Mr. Shackleton's party would be utilized as far as possible in determining the special circumstances in which each would be employed. Thus, ponies proved suitable for traction over the surface of the barrier, but not for glacial work, for which dogs would be used. Although Mr. Shackleton's motor-car did not prove a success on the soft snow of the barrier, much is hoped of a new type of motor-sledge with which experiments have been recently made. Food would therefore be transported to the foot of the glacier either by ponies or by motor-sledges, while the final dash to the pole, once the plateau had been reached, would be made with the help of dogs. The scientific objects of the expedition may be briefly stated as follows: 1. Geographical.—To explore King Edward's Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. 2. Geological.—To examine the entirely unknown region of King Edward's Land and continue the survey of the rocks of Victoria Land. 3. Meteorological.—To obtain synchronous observations at two fixed stations as well as the weather records of sledge journeys. 4. Magnetic—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw important light on secular changes. 5. Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued. The plan which has been outlined to secure the main object of the expedition, together with subsidiary plans for the complete exploration of the region of King Edward VII. Land, will necessitate the establishment of a strong party of men at the winter stations and a more ample equipment than has hitherto been taken. It follows that the ship in which the expedition embarks must be suitable in size as well as strong enough to enter the heavy pack ice likely to be met with in the region of King Edward VII. Land. These considerations prevent the full realization of the project under a total estimated expenditure of £40,000. The steamship *Terra Nova,* which served as a relief ship in the *Discovery* expedition, has been purchased for the expedition.

A letter from Mr. Ellsworth Huntington, of Yale University, states that he returned home early in October, after a profitable journey of eight months. After exploring the Dead Sea he made expeditions in to the wild border regions of the Syrian Desert, the Negeb or South Country, the Druze Mountains and the Leja with its volcanic flows and went as far as Palmyra and northern Syria. Throughout the journey, special attention was paid to climatic problems, and it was found that the phenomena of Palestine agree with those of Central Asia in a remarkable degree. In early July, Mr. Huntington went up to Asia Minor by way of the Cilician plain and the city of Adana. The months of July and August were devoted to a study of the lakes of Central Asia Minor. On the way home from Turkey a flying visit was paid to Greece. A study of the alluvial deposits which cover the Olympian plain and from the midst of which old Olympia has been excavated, yielded evidence of the manner in which the climatic history of Greece has been parallel to that of regions 2,000 or 3,000 miles farther east.

King Edward has conferred the order of the Indian Empire on Dr. Sven Hedin, the distinguished Swedish geographer and traveler.

News has been received from Dr. T. G. Longstaff to the effect that he has arrived at Leh, in Ladak, after having connected the Tarim river with the Saichar glacier.

Mr. Shackleton has left England on a continental tour, and is to tell the story of his Antarctic expedition in the principal cities of Europe. On

October 9 he was to be the guest of the Royal Geographical Society at Copenhagen. He will proceed to Stockholm and Christiania, and afterwards will visit Brussels, Antwerp, Berlin, Rome, Vienna and Paris. In March he leaves England for America on an extended tour.

It is stated in the *Nation* that the Russian Ministry of Marine is equipping three expeditions to be sent out in the year 1910 to explore the coasts of the Arctic Ocean. One steamship will go from Vladivostok to find its way along the coast of northeast Siberia from Bering Strait to the mouth of the Lena, and is to spend from three to four years in this task. A second expedition will visit the Taimyr Peninsula for hydrographical and topographical investigations. The third expedition, which, like the last, starts from St. Petersburg early in 1910, will follow the land route to the Taimyr Peninsula, and will study particularly the courses of the rivers and the geology, climate and meteorology of the country, establishing local meteorological stations.

ACTIVITIES OF THE SOCIETY

EXTRACT FROM ANNUAL ADDRESS OF HENRY G. BRYANT, PRESIDENT GEOGRAPHICAL SOCIETY OF PHILADELPHIA, STATED MEETING, NOVEMBER 3, 1909.

Mr. Bryant, after referring to some of the geographical achievements of the past year said in part:

The early days of September witnessed the most stirring announcements of this "annus mirabilis" in the history of exploration. While many of us were wondering in our own minds if we should live to see the North Pole discovered in our lifetime—the news of its double conquest by two well-known American explorers was flashed to the world by two messages which were published within five days of each other. Thus in the fullness of time, came the announcement of an event for which the world has waited for over three hundred years. In spite of the impractical nature of the quest there has been a glamour about the search for the pole which has impelled some of the noblest figures in history to attempt its attainment. Many generations of heroic navigators essayed the search and their failures seemed only to emphasize the apparent inaccessibility of the goal. Within the last twenty years, however, the advances have been notable and the honors of the farthest north have in turn been held by Norway, Italy and the United States.

While the history of Arctic exploration shows that the grim North has collected her toll in lives and treasure from those who have invaded her solitudes—none can say the sacrifices have been in vain—science has been enriched and the boundaries of human knowledge enlarged, and, most important of all, these expeditions have heretofore served the purpose of cultivating those qualities which we most admire: courage, self sacrifice and devotion to high ideals of duty.

While learned geographers have in the past deprecated the zeal expended in attempts to reach the pole, on the ground that no special scientific interest is associated with that particular spot on the earth's surface—the world-wide interest manifested in its discovery has shown how genuine and universal was the popular feeling on this question. An English writer[1] has recently voiced this feeling: "There is a vast attraction in the struggle to attain an extreme latitude in polar exploration, and although it is usual for explorers and almost invariable for critics to make little of this incitement to exploration, there must always be for the geographer the feeling that it is, after all, a very great thing to press towards the mark of latitude 90°. The tradition of inaccessibility is a challenge to humanity, and, whether it be the end of the earth's axis or the summit of a snowy mountain which throws down this challenge, there will never be lacking a few to take it up and many to applaud the enterprise. More valuable scientific work and more lucrative commercial returns will accrue for a long time to come from easier and less fascinating adventures; but the desire to wipe out *terra incognito* appeals more deeply to certain instincts of human nature than either science or trade, and the rough-and-ready test of highest latitude is in one sense a gauge of human progress."

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[1] Dr. H. R. Mill, *Geographical Journal*, London, May, 1909, p. 570.

Judged by this criterion, our country has indeed made an advance in civilization, for to America has come the supreme distinction of having first reached the highest attainable latitude 90° north and the pole. Unfortunately our elation and pride in this unique achievement, is lessened by the unhappy controversy which has arisen between the adherents of Dr. Cook and Commander Peary for priority in this great achievement. For two months a journalistic war has raged over these two explorers and the entire country is divided into two camps on the question as to who was first in reaching the pole. To end this intolerable situation efforts have been made to induce the explorers to refer their data to some authoritative tribunal in this country capable of passing on the questions at issue.

Dr. Cook has not seen his way to avail himself of this method of settling the question, as he had previously agreed to submit his documentary proofs to the University of Copenhagen. Of course Dr. Cook is within his personal rights when he selects the tribunal to which he will submit his data. It is unfortunate, however, that he has delayed and continues to delay presenting his proofs to the University of Copenhagen, when all that need and should be submitted are the original figures put down by Dr. Cook in his note book at the time his observations were taken. We learn that Commander Peary has already turned over his material to a committee constituted in Washington to pass on his records and a report on his recent expedition may be expected within a reasonable time.

In view of the present status of this unfortunate controversy, the board of directors of this society at its meeting of October 13 passed the following: "Resolved that the Geographical Society of Philadelphia maintains a non-partisan attitude in regard to the unfortunate controversy relating to the discovery of the North Pole and approves of the proposed reference of the data of the two explorers to a committee to be appointed by the president of the National Academy of Sciences for examination and report."

In common with other students of Arctic research, I have taken much interest in recent events and have opinions of my own on some aspects of the subject. In view, however, of the deliberate policy of this society to maintain a neutral position and influenced also by the consideration that I appear this evening in a representative capacity—I do not consider that it would be becoming in me to attempt any review of the polar dispute or to advance any personal views relating to the work of the two explorers.

In concluding this portion of my remarks, let me ask you not to be so influenced by mere personalities as to forget the great historical fact which rises above the present discussion that this great prize of the centuries—the conquest of the North Pole—has been won for America. Let us at least take this solace to our souls. The future will decide who most deserves the laurels of victory.

THE CONQUEST OF THE POLE

Address by

COMMANDER ROBERT E. PEARY.

Stated Meeting, Dec. 1, 1909.

The successful expedition of the Peary Arctic Club, culminating in the reaching of the pole in April, 1909, was described by Commander Peary at the December meeting of the Society. Much of the story was told graphically by the many excellent lantern slides, a number of which were artistically colored to give an idea of Polar scenes in their true light.

The lecturer dealt at considerable length on the problems to be encountered in Arctic work, and emphasized strongly the importance of his Eskimo helpers, the Eskimo dogs, but most of all the invaluable experience and lessons of previous attempts. Experience, showing the best line of attack, teaching the needs of equipment, the ways of utilizing every last detail to advantage—experience was the keynote of success.

Perhaps the most striking single point in the address was the description of the pressure ridges and the problem represented in making any kind of rapid advance over them. To most people it came as a surprise to learn that these high barriers of piled up jagged ice are encountered at intervals of never more than five miles, and usually much less, throughout the four hundred miles from Cape Columbia to the Pole. The task of getting the sledges past these obstacles was plainly so great that only an elaborately organized expedition could hope to make more than a very few miles a day. The fact that of the twenty-four sledges which left Cape Columbia only seven returned indicates the sacrifice which must be made to speed, even when a series of advance and supporting parties are employed to lay out and practically to hew a trail for the explorer himself.

The lecture demonstrated beyond question that the attainment of the Pole was not the result of chance, accident or any other combination of variable circumstances, but was the logical outcome of dogged persistence, perfect equipment, and the scrupulous observance of every detail which previous years of experience had shown to be necessary.

BOOK NOTES AND REVIEWS

Baedeker, Karl. *The United States.* Pp. 724. Fourth edition. Karl Baedeker, Leipzig, 1909.

The great size of this country and the rapidity with which conditions change have long made desirable a new edition of this guide book, valuable alike to foreigners and to Americans touring in the United States. Occasional items concerning the country are likely to appear somewhat amusing to the average Americans, but taken as a whole the volume will be found by all to be an invaluable aid in getting acquainted with their own country.

Castillo, B. D. del. *The True History of the Conquest of New Spain.* Pp. 396. Translation by Prof. A. P. Maudslay. The Hakluyt Society, London, 1908.

Much interest is attached to this printing, at last, of an exact translation of Castillo's True History of the Conquest of New Spain. As one of the conquerors Castillo's account of the conquest of Mexico has long been accepted as the most complete and trustworthy chronicle of the Spanish campaigns. Earlier publications and translations of the True History have been lessened in value by the changes introduced in the Madrid edition on which the others were based, so that the True History, except from the original manuscript, has never really been available until now.

The chronicle covers the discovery of New Spain, the expeditions under Grijalva and under Cortez, the march inland from Vera Cruz and the war against the Tlaxcalans. Numerous interesting cuts are included in the text, while appended maps, and an exhaustive bibliography add further to the high standard of the volume.

Johnson, Emory R. *Elements of Transportation.* Pp. 360. D. Appleton & Co., New York, 1909.

This important addition to the author's series of books on transportation serves as a general introduction to the whole subject. The book is divided into four parts, each of which deals in considerable detail with one of the phases of transportation: steam railways, electric railways, ocean transportation, and inland waterways. The relative merits of the different phases account for the fact that the discussions of steam railways and of ocean transportation make up approximately four fifths of the text. Both of these subjects are covered more exhaustively in the author's volumes dealing respectively with those special aspects of the transportation question.

The value of the present volume lies in the able presentation of the essential points in all phases of transportation. It will be found invaluable in the many cases where a general manual on transportation is desired.

Putnam, G. R. *Nautical Charts.* Pp. 162. John Wiley & Sons, New York, 1908.

All who have any use of, or interest in, nautical charts will welcome this volume by the one time director of the Philippine Coast Survey. The author begins with a brief survey of the development of chart making and points out what the chart should show. Then follows a very careful exposition of how the necessary information should be gathered, its preparation, publication and correction—thus constituting literally a brief manual for the geodetic surveyor. The discussion of the use of nautical charts concludes the volume. Many illustrations aid materially in supplementing the text, and contribute much toward making the book interesting to anyone at all interested in geographical matters.

THE SCENERY OF NEW ZEALAND.[1]

P. G. MORGAN.

INTRODUCTION.

No country in the world possesses a greater variety of beautiful scenery than New Zealand. The land is clothed with luxuriant forests which by their luxuriant growth and by their wealth of tree ferns and lianes recall those of tropical climes. In the marvellous thermal region of the North Island are hot lakes, mud volcanoes, fumaroles, boiling springs, geysers, and many other remarkable volcanic phenomena. The rivers, rising in mountain fastnesses, pass with many a cataract and rapid through deep rock-walled canyons. Among the many beautiful waterfalls are some of the highest known to exist. The mountains, whether the volcanic piles of the North Island or the snow-clad peaks of the Southern Alps, evoke the admiration of all beholders. There are great glaciers, rivalling those of Switzerland, and descending in magnificent ice-cascades to the lowlands. The coast presents every variety of outline, and has as its crowning glory the splendid fiords of western Otago.

A feature that must attract every lover of nature is that most of New Zealand's finest scenery lies, comparatively speaking, in the wilderness, and is almost or entirely untouched by the hand of man. In many places the advance of settlement has, it is true, rendered necessary the destruction of the forest, and mining operations are sometimes responsible for discolored streams or ugly hillside scars. Yet, on the other hand, the progress of civilization has made it possible for the ordinary traveller to see most of the finest sights without difficulty or discomfort, while for those of hardier frame there still remain many unclimbed peaks and many unexplored valleys.

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[1] For information concerning the scenery of localities not personally visited, the writer is indebted mainly to "New Zealand," an excellent guide-book written by James Cowan, and published by the New Zealand Tourist Department (1907).

THE FOREST.

Even at the present day probably one half of New Zealand is covered by forest, or, as the settler commonly calls it, "bush." Seen from a distance the forest generally appears dark and sombre, owing to the prevalence of dull shades of green. In summer, however, whole mountain sides may be splendent with the crimson bloom of various species of rata (*Metrosideros*), and the northern coasts may be made glorious to behold by the thick-massed, dark-red flowers of the shore-loving pohutukawa (*Metrosideros tomentosa*). The kowhai (*Sophora tetraptera*) has an abundance of pendulous yellow blossoms, but most of the other bush flowers are white. Among the many notable trees are the stately kauri (*Agathis australis*), found only in the north, the graceful rimu (*Dacrydium cupressinum*), with its drooping branchlets, the matai (*Podocarpus spicata*), the totara (*P. totara*), the titoki (*Alectryon excelsum*) and the larger species of *Metrosideros*.

It is a characteristic of New Zealand forest that in a small area not one or two but many forest trees may generally be found. This feature, in marked contrast to the forest areas of temperate America, adds much to the charm of the bush. The luxuriant undergrowth and the abundance of tree ferns and lianes, together with the presence of many epiphytes and of a true palm, the beautiful nikau (*Rhopalostylis sapida*) give the bush that aspect of tropical splendor so often noted by visitors. Besides the great tree ferns, often thirty to fifty feet in height, there are scores of smaller ferns, many of most exquisite beauty, so that it is no wonder that one of the most cherished delights of New Zealand maidens is to go a-ferning. Gaily colored parrots, white-breasted pigeons, dark-plumaged tuis, and the sweet-toned makomako or bell bird, as well as many another songster of the bush flit from tree to tree. In most districts may be seen one or more species of those remarkable flightless birds for which New Zealand is famous. There is much, then, to charm the naturalist, whether botanist or ornithologist, as well as the mere traveller in the woodland of this favored region.

The finest forests in New Zealand are perhaps those of the western coast of the South Island, where the humid climate offers the most favorable conditions. Elsewhere, however, in Stewart Island, in Nelson, on the slopes of Mt. Egmont, around Lake Weik-

A River-boat Steaming up Ngaporo Rapids, Wanganui River. (Photo by New Zealand Tourist Department.)

Lake Kanieri, Westland. (Photo by New Zealand Tourist Department.)

aremoana, and on the Coromandel Peninsula, are forests almost equally magnificent. The Coromandel Peninsula too, in common with North Auckland, boasts the presence of the kingly kauri, noblest and stateliest of New Zealand trees. This splendid tree, unlike many of its fellows, usually grows in clumps or patches to the almost total exclusion of other forest trees. The shrubby undergrowth of the kauri forest is scanty, a carpet of lycopodiums and mosses taking its place. The kauri, under the vigorous attack of the lumberman, or "bushman" as he is more picturesquely called in Australasia, is fast disappearing from most localities. In the North Auckland Peninsula an area of kauri forest and mixed bush, known as the Waipoua State Forest, has been set aside as a reservation by the government of the dominion. Here, provided it can be protected from the ravages of fire, shall the kauri find sanctuary and be the delight of mankind in the long centuries to come.

THE THERMAL WONDERLAND.

From Mount Ruapehu in the center of the North Island there stretches to the northeast a belt of country marvellous for its solfataric phenomena. Here, in addition to the active and extinct volcanoes mentioned by Dr. Bell in the first part of this paper, may be seen innumerable mud volcanoes, boiling springs, steaming ponds, fumaroles, and geysers. In close proximity to these weird manifestations of volcanic energy are wonderfully beautiful cold springs, lakes, waterfalls and rapids. Though the characteristic New Zealand forest does not flourish in the areas of most intense solfataric activity, yet very fine bush may often be seen not far away, and many spots gain added charm from the presence of beautiful ferns and other plants. One or two species of ferns are said to be peculiar to the neighborhood of the hot springs, and in the almost boiling water live those remarkable algæ to the agency of which the formation of siliceous sinter is in great measure due. All through the thermal region are picturesque Maori settlements, the inhabitants of which are ever ready to show the visitor the wonders of the vicinity.

At Rotorua, on the shores of the lake of the same name, and at Whakarewarewa, two miles away, one may see every phase of solfataric action. There are spluttering mud pools and volcanoes, deep shafts filled with beautifully blue water through which steam bubbles occasionally ascend, springs in violent ebullition, geysers, steam jets, sulphur-incrusted crevices, acres and acres of sinter in various shades of white, gray and pink, strange subterranean gurgles and explosions. Great white clouds of steam arise from the areas of most intense action, and are particularly noticeable just after sunset or before sunrise.

Now that the giant Wiamangu has ceased to play, the geysers of Whakarewarewa are the largest in the thermal region. One of these, named Wairoa, throws a great shaft of boiling water to a height of eighty or one hundred feet. The geyser Pohotu in its rare displays is almost the equal of Wairoa. These geysers are very irregular in their action, but it is possible to foretell their eruption by perhaps an hour or more. The gurgling and spluttering and bubbling of the water in the throat of the geyser increase in activity. The imprisoned monster is trying to shake off his shackles. By and by the water begins to rise and fall spasmodically. Finally it overflows the geyster tube, then perhaps momentarily sinks back a few inches, but quickly regains the surface. Spouting now begins, and the column of water gradually climbs higher and higher. Soon the greatest height is reached, and then after maintaining itself at this point for some minutes, the geyser, exhausted by its efforts, slowly subsides.

At Tikitere, on the eastern shore of Lake Rotorua, are immense pools of fiercely boiling mud that impress the visitor's imagination with visions of an inferno as terrifying as the lowest circle of Dante's.

The enchanting Hamurana Spring offers a most complete contrast to Tikitere. Crossing Lake Rotorua in a small steamboat, one is rowed up a stream of beautifully clear water, the shallow bed of which is covered by exquisite water plants. Suddenly one comes to the source of the stream, a great spring of cold water gushing up from a crevice in solid rock. All around are overhanging shrubs and trees, whilst over a rocky face just ahead climb beautiful ferns and mosses.

Twenty miles south of Rotorua is Waiotapu, with a very fine mud volcano, sinter, terraces, boiling springs, and alum-encrusted cliffs. Near Waiotapu is Maungakaramea, or "Mountain of Colored

Earth," remarkable for the vivid tints of red and yellow displayed on its steeply pitched, scarred flanks.

Orakeikorako, on the banks of the Waikato about twenty miles north of Lake Taupo, besides boiling springs and fumaroles, has beautiful sinter terraces. The geysers of this locality are now dormant or extinct. They last played when the Waikato River was unusually high after heavy rain. Wairakei, a few miles from Lake Taupo is one of the most interesting spots in the thermal district. Its numerous geysers are small, but they play regularly and frequently. The Dragon's Mouth, for example, has an interval of only nine minutes between its eruptions. Not far from Wairakei is the lovely Waiora Valley, where in a setting of semi-tropical forest, may be seen mud volcanoes, hot springs and beautifully colored lakelets. Near the point where the Waikato River leaves Lake Taupo are several geysers and many boiling springs. The largest of the geysers is the Crow's Nest, which at intervals of about two hours throws a column of boiling water to a height of eighty feet.

Among the many other spots in the thermal region where may be seen boiling springs and other solfataric phenomena may be mentioned Waikite at the eastern foot of the Paeroa Range, Tokaanu at the south end of Lake Taupo, the slopes and summits of the great volcanic mountains of Ruapehu, Tongariro and Ngauruhoe.

Finally reference ought to be made to White Island, in the Bay of Plenty, a volcano apparently in the solfataric stage, as a most remarkable and interesting spot.

RIVERS AND WATERFALLS.

The most beautiful of New Zealand rivers is probably the Wanganui, which may be navigated by small craft for over one hundred and forty miles from its mouth. In the lower reaches of the river evidences of European civilization prevail, but farther up picturesque Maori villages become numerous, and canoes laden with athletic *tangata* and gaily dressed *wahine* are frequently seen. The country gradually becomes wilder and signs of occupation by man disappear for stretches of many miles. There is some fine scenery below Pipiriki, sixty miles from the mouth of the river, but from Pipiriki to the head of navigation at Taumaranui is a marvellous succession of river scenery. The stream flows through gorge after gorge, with precipitous falls half hidden by exquisite ferns and mosses. Where sufficient foothold is given evergreen shrubs have taken root, whilst on the cliff tops and on the gentler slopes characteristic New Zealand forest appears. The tender colors of the vegetation are enlivened in spring by the yellow blossoming kowhai and the white flowering clematis, while in summer the crimson glory of the rata covers the hillsides. Cataracts stream down the mossy cliffs, and in the waters of the calm reaches are wonderfully perfect reflections of land and sky.

The scenery of the almost unknown Mokau River in Taranaki is of similar type to that of the Wanganui, and is said by those who have seen it to be equally charming.

The Waikato River, especially in that part which flows through the thermal region, offers some wonderfully fine scenery. A few miles below its exit from Lake Taupo, and not far from Wairakei, it enters a narrow defile cut in volcanic rock, and gradually gathering speed, thunders over a cliff in one white solid mass. Though not of great height, the Huka Falls, by reason of their volume and surroundings are most impressive.

Two miles below the Huka Falls are the Aratiatia Rapids, one of the finest sights in New Zealand. Here the swift foaming waters of the great stream, confined to a narrow rock encumbered channel, pass through a wooded gorge. The exquisite blue green of the smooth water, the pure white of the foam, the varied tints of the forest, and the dark-coated volcanic rocks, give wonderful color harmonies, but it is the might and majesty of the spectacle that make an unforgettable impression on the beholder. Below the Aratiatia Rapids, notably near Orakeikorako and at Atiamuri, are other fine rapids and falls. In its lower course the Waikato becomes a deep navigable stream, with dark-colored waters and generally low banks.

The Thames or Waihou River, which flows northward into the Firth of Thames, has many beautiful reaches along its willow-lined course. One of its tributaries, the Ohinemuri, passes through a fine gorge at Karangahake, a few miles from Waihi. The gorge of the Waitawheta stream, near the same place, is even more rugged and picturesque. The northern Wairoa River, a navigable stream which enters Kaipara Harbor from the north, in its upper source passes through some fine kauri forest. Above the head of navigation are the beautiful Wairua Falls.

Other than those already mentioned there are comparatively few waterfalls of note in the North Island. Near Auckland the Nihotapu Falls are well known, and easily accessible. There are many falls of small volume in the rugged Coromandel Peninsula and the range forming its southward extension. The Wairere Falls on the eastern side of this range, a few miles south of Te Aroha, are probably over 1,000 feet in height. Near the shores of Lake Taupo and in the neighborhood of Lake Waikaremoana are a number of beautiful falls that with their forest setting add to the charms of these fine lakes.

In the South Island much of the river scenery is of a bolder type than that of the North Island. The well-known gorge of the lower Buller River presents a fine combination of river, forest, and mountain scenery. The magnificent Otira Gorge, on the coach route over the Southern Alps, surpasses the Buller in the grandeur of its mountain scenery. South of the Otira Gorge one may see in the valleys of the various alpine rivers many wilder and even more magnificently rugged gorges. Like the Otira, these gorges are more properly to be classed as mountain rather than river scenery. There are few waterfalls on the main streams, but there are many remarkable cascades in their upper reaches. The smaller streams descend from hanging valleys in countless cataracts and falls of great beauty.

The Taieri, Clutha and other rivers in central and eastern Otago present much fine scenery. Everywhere in the rugged region of western Otago are wonderful gorges and waterfalls. Among the latter may be mentioned the Bowen Falls (540 feet) and the Stirling Falls (500 feet), both on the shores of Milford Sound, while a few miles from the head of the same fiord are the great Sutherland Falls which, descending like the Bowen and Stirling falls from a typical hanging valley, are no less than 1,904 feet in height.

LAKES.

Most of the North Island lakes deserving mention from a scenic point of view are in the Taupo volcanic zone. Though as a rule greatly inferior to the glacial lakes of the South Island in point of magnificence and rugged picturesqueness of their surroundings, these lakes are far from being devoid of beauty. Many of the smaller lakes have waters of marvellous green or blue-green tints, and, surrounded as they often are by charming forest, contrast most pleasantly with the thermal manifestations.

Lake Taupo, the largest lake in New Zealand, with its wide expanse of blue water, in many places bordered by high cliffs or steep wooded slopes, is easily the most attractive of the major volcanic lakes. Here and there Maori villages dot its shores, while near-by columns of steam rise from boiling springs. In the northern distance may be seen the three great volcanic mountains, Tongariro, Ngauruhoe, and Ruapehu, the last named crowned by perpetual snow.

Most beautiful of all North Island lakes is Waikaremoana, the "Sea of the Rippling Waters," situated about fifty miles (airline) north of Napier. With its many sandy-beached bays and coves, its bold rocky headlands covered by luxuriant forest, and its mountain background, Waikaremoana challenges comparison with the finest lakes of the South Island. Many are the legends told by the old Maoris of dread monsters that inhabit the lake, of enchanted rocks and trees on its shores, of fairy sprites dwelling in the recesses of the neighboring forest. Here, forty years ago, the famous rebel Te Kooti had his strongholds and hiding places, and here in still earlier days, when war was alike the pastime and the noblest occupation of every tangata, was the scene of many a raid and foray and cannibal feast.

Practically all the scenic lakes of the South Island are in mountainous regions, and occupy valleys or hollows formerly filled by glacier ice. In Nelson, lakes Rotoroa and Rotoiti (which must not be confounded with Rotorua and Rotoiti of the North Island) are small sheets of water of great beauty. In Westland, lakes Brunner, Kanieri, Ianthe and Mapourika are those that may most easily be visited. All are fringed by splendid forest. Of these perhaps Lake Kanieri is the most beautiful at the first glance, but the larger Lake Brunner has a greater variety of views. In Canterbury on the eastern side of the Alps are many fine lakes, but they lack to a great extent the forest surroundings that add so much to the charm of the Westland and most of the Otago lakes. Of the latter Wakatipu is a long winding lake with high mountains on every side. The lake

A Glimpse of Lake Manapouri from the Road. (Photo by New Zealand Tourist Department.)

Looking towards Entrance, Whangaroa Harbor. (Photo by New Zealand Tourist Department.)

appears at its best in spring or early summer, when the winter snows are still on the lower mountain slopes. Lakes Hawea and Wanaka, lying to the north of Wakatipu, present similar views. The scenery of Lake Te Anau, south of Lake Wakatipu, is wilder and grander than that of the three lakes just mentioned. This lake, the largest in the South Island, has several fiord-like arms penetrating far into the western mountains. The Mavora lakes, between Wakatipu and Te Anua, are lovely little sheets of water, surrounded by fine beech forest. Lake Manapouri, a few miles south of Te Anau, has been described as the finest of all New Zealand lakes. Characteristic New Zealand forest borders its shores, which almost everywhere rise precipitously to jagged rocky peaks, wreathed by perpetual snow.

Besides the lakes mentioned, western Otago has hundreds of others, any one of which is a scenic gem, and undoubtedly there are many small lakes yet to be discovered in this partly unexplored region.

Mountain Scenery.

The hills and mountains of New Zealand present a wonderful variety of outline. In the course of ages some have been worn by the forces of nature into eminences with comparatively gently rounded swelling outlines, but in general the mountains are relatively young, and exhibit deeply dissected slopes and frowning precipices. Their summits and storm-scarred flanks, except where too steep to allow any lodgment of loose material, are mantled with eternal snows, which give rise to magnificent glaciers. Other mountains again are perfect volcanic cones, some of which rise above the summer snow-line. Almost everywhere the lower slopes of the mountains are clad with luxuriant forest, a feature that often renders their ascent difficult, but adds greatly to their charms.

In the North Island the mountains of greatest scenic attraction are of volcanic origin. The central knot south of Lake Taupo, with Tongariro, Ngauruhoe and Ruapehu as its chief summits, has already been mentioned. The view from the crater of Tongariro is especially fine. The somewhat irregular well-dissected mass of Ruapehu is grand and impressive from every point of view. It may be mentioned that practically the whole area covered by these mountains and their slopes has been set aside by the New Zealand government as a scenic reserve, to be known as the Tongariro National Park.

Nothing more beautiful than the almost perfect cone of Mt. Egmont, with its forested slopes and snowy summit, can be imagined. A volcanic ridge which runs southward from Egmont for some miles adds to, rather than detracts from its effect on the imagination.

The many relatively low cones near Auckland are not only of great interest owing to their volcanic origin and numerous perfect craters, but from their summits give exquisite views of land and sea. The element of grandeur is to some extent lacking, but the green fields and pretty villa residences of the land, the calm and sheltered waters of the sea studded with the white sails of fishing boats and yachts, give a feeling of peace and security in sharp contrast to the thoughts inspired by the deep crater at one's feet.

Equally charming are the views obtained from the peaks of the Coromandel Range, for example from Mt. Moehau near Coromandel, or from the highest point of the range, Mount Te Aroha (3,126 feet). Karangahake Hill, near the mining township of the same name, is a magnificently sculptured monolith, the beauty of which not even the mining operations conducted on its flanks have impaired.

The mountain ranges that under several names extend from Wellington to the East Cape afford many fine views, both as seen from a distance and at close quarters. Though nowhere permanently snow-clad they are in many places of wild and rugged character.

Coming to the South Island, the Inland and Seaward Kaikoura Ranges in the northeast may be first mentioned. In winter and early summer, when still snow-clad, these mountains as seen from the sea afford a very fine spectacle. Towards the end of summer the snow may almost disappear, but the bold rugged outlines still remain impressive. Rising as they do to heights of over 9,000 feet, and lying within sight of New Zealand's capital city, the Kaikouras, the least regarded of our mountain ranges, deserve more attention.

Central and western Nelson may be described as a sea of peaks, many of which were once glaciated. These rugged masses of granite or indurated Palæozoic rocks afford every possible variety of rock scenery. Their lower slopes are everywhere densely wooded, and on the higher slopes flourishes an exquisite alpine flora.

Throughout Westland and Canterbury the Southern Alps form a magnificent snow-clad range, with numerous peaks rising above 10,000 feet. As viewed from the Canterbury Plains the Alps are a glorious sight, especially on a fine winter morning when the rays of the rising sun are reflected from their snowy flanks. On a somewhat nearer approach one sees many splendid peaks, even among the subsidiary outlying ranges. At the heads of the Waimakariri, Rakaia and Rangitata rivers and their various tributaries is wonderfully fine mountain and glacier scenery, much of which was described by the late Sir Julius Von Haast in his "Geology of Canterbury and Westland."

The grandest scenery on the Canterbury side is of course in the Mount Cook district. From the Hermitage hostelry as a base the neighboring glaciers may be visited and many noble peaks climbed. Mount Cook itself, the monarch of the Southern Alps, has as yet been climbed but six times, and only thirteen persons have stood on its topmost ridge. There can be no doubt, however, that the finest alpine views are on the western side of the mountains. Even from the coast line the alpine range appears magnificiently grand and forms a sight never to be forgotten. From any of the outlying peaks along the western margin splendid views of sea, lowland and mountain may be obtained.

In the heart of the Westland mountains the scenery is wild and rugged in the extreme. As one ascends the river valleys, he may see towering peaks, wonderfully weather-carved rocks, tremendous precipices, wide snow fields and great glaciers. All is magnificently sublime beyond description. In contrast with the rcoks and snowfields is the unique alpine flora, with its many beautiful flowers. This grows at heights of from 3,000 feet to the permanent snow-line, which on ordinary slopes is about 6,000 feet. Up to the zone of alpine plants the mountains on the Westland side are clad with a luxuriant forest that adds much to the scenic effects. On the Canterbury side the forest is less abundant, and when present consists mainly of species of beech.

South of the noble peak of Mt. Aspiring (9,975 feet), where the provinces of Canterbury, Westland and Otago meet, is the remarkable congeries of partly unexplored mountains that enclose the great glacial lakes of Otago and wall in the fiords of the western coast. Steep-walled ice-carved canyons are a notable feature of this area. Through this wilderness two or three tracks have been made. One of these, from the head of Lake Te Anau to Milford Sound has been described by unbiased persons as " the finest walk in the world." This track passing up the Clinton Valley with its precipice walls thousands of feet high crosses McKinnon Saddle, and then drops into the Arthur Valley, another deep glacial canyon that is followed until Milford Sound is reached.

Glacial Scenery.

On the slopes of Mt. Ruapehu are several small glaciers—the only ones in the North Island. In the Southern Alps, however, are hundreds of ice-streams of all sizes from tiny cliff glaciers to the great Tasman Glacier eighteen miles in length. The most northerly of these is probably a beautiful little cliff glacier that may be seen from Arthur's Pass on Mt. Rolleston. Every river valley in Westland from the Hokitika southward contains glaciers of varying size, but space forbids one to particularize. The little known Wilkinson Glacier, near the head of the Whitcombe, must be mentioned on account of its exquisitely beautiful icefall. Again, the valleys of the Westland Wanganui and its tributaries contain some very fine though not particularly large glaciers. Further south are the wonderful Franz Josef, Fox and Douglas glaciers, described by Dr. Bell in the first section of this paper.

On the Canterbury side of the Alps there are glaciers well worth a visit at the head of the Rangitata River and its branches; and again at the head of the Rakaia is the splendid Ramsay Glacier. The great ice-rivers of the Mt. Cook region—the Tasman with its marvellous ice-cascade known as the Hochstetter Icefall, and the Mueller, Hooker, and Murchison glaciers, are on account of their accessibility better known than any of the Westland glaciers. It cannot be doubted, however, that the latter are the finer in almost every respect. In the case of the Franz Josef and Fox glaciers the contrast between the ice and the luxuriant forest that surrounds their lower limits is one of the most effective factors in bringing about their scenic superiority to the Canterbury ice-streams.

COASTAL SCENERY.

The coast line of New Zealand, as might be expected from the relief displayed by the land surface, presents varied types of scenery. There are sheltered bays and inlets reaching far into the forest clad land, there are rock-girt and storm beaten stretches of coast with high cliffs and rugged promontories, there are long sandy beaches upon which the ocean swell leisurely breaks. Again we have a deep gulf studded with islands of all sizes, a great bay in the midst of which a still-active volcano rises above the waters, a wide strait where opposing tides are ever struggling for the mastery. Finally there are the magnificent fiords of western Otago, the equals of those of Norway or southeastern Alaska.

The North Auckland Peninsula contains a number of fine inlets, due to recent subsidence of the land drowning river valleys. Of these, Whangaroa Harbor on the eastern coast, is scenically perhaps the most interesting. The Bay of Islands and Whangarei Harbor are other beautiful inlets farther to the south. The Waitemata Harbor, on which stands Auckland, the largest town in New Zealand, has many charming features. Its entrance is guarded by the beautiful island cone of Rangitoto.

The Hauraki Gulf, with its many green islands and sheltered passages is a yachtsman's paradise, and whether viewed from the deck of a steamer or from any of the volcanic cones near its shores, offers many beautiful views of land and sea.

The coast line from Coromandel Peninsula to Wellington is everywhere attractive, except possibly in the inner part of Hawkes Bay, where it is low-lying. Mercury Bay, Tologa Bay, Poverty Bay, and many of the capes and headlands are associated in New Zealand memories with the name of the great navigator Cook.

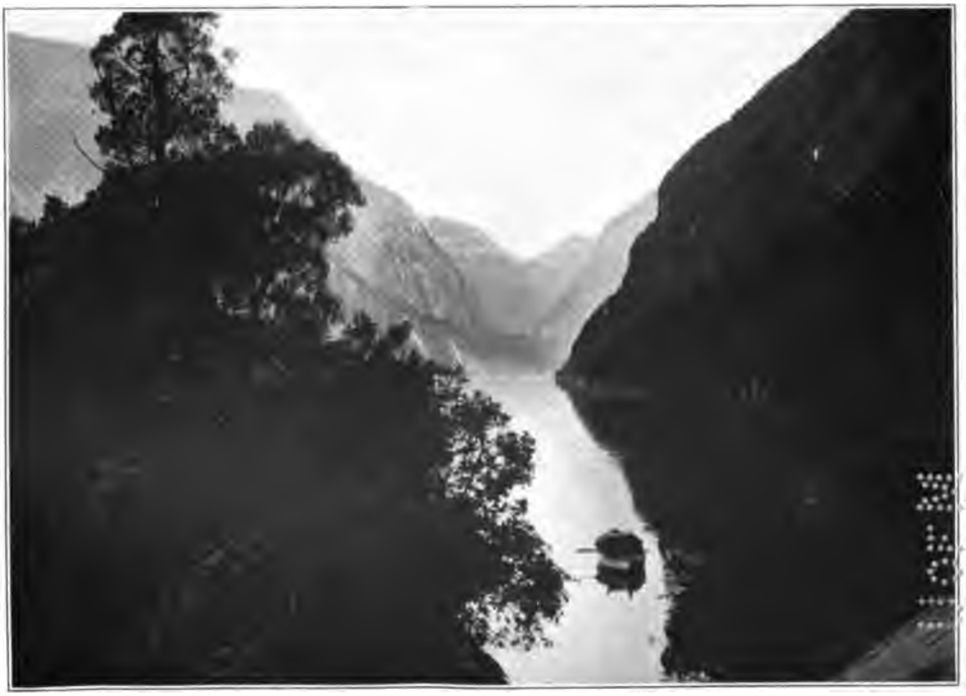
On the west coast of the North Island, Kawhia and several other harbors present fine scenery. In the North and South Taranaki Bights, the snowy cone of Mt. Egmont is the dominating feature of the view. The shores of Cook Strait afford some bold coastal scenery. Wellington Harbor, naturally a fine sheet of water, and once largely surrounded by bush, has not been improved from a scenic point of view by the building of a city on its shores.

Very lovely is the scenery of the Marlborough Sounds, with their intricate coast line. Of the forest which once wholly covered the hills enclosing these sheltered waters the greater part still remains. At Ship Cove in Queen Charlotte Sound, Cook used to make long stays during his voyages in order to obtain wood and water, and recruit his sea-weary crews.

On the east coast of the South Island one may mention the harbors of Akaroa and Dunedin as scenically interesting. The latter, notwithstanding the great destruction of bush that has taken place along its shores, is still one of the most charming sheets of water in New Zealand. The voyage from Nelson to Greymouth along the northern and western coasts of the South Island allows one to see some fine stretches of coast. South of Greymouth, the great attraction until the Otago fiords are entered, is the wonderful view of the Southern Alps a few miles inland.

The Fiords of Western Otago.—In comparatively recent times western Otago seems to have undergone considerable depression, and in consequence a number of glacial valleys have become arms of the sea. Of the many splendid fiords thus formed the most northern one—Milford Sound—is by common consent agreed to possess the most magnificent scenery of all. Everything about Milford is grand and impressive, but its most sublime feature is furnished by the tremendous precipices that rise to heights of thousands of feet, and, were the fiord emptied of its waters, would be seen to continue a thousand feet or more beneath the present water-line. The neighboring mountains, ascending to heights of from 6,000 to 9,000 feet, support snowfields and glaciers. On their lower slopes, where not too steep, luxuriant forest flourishes in that moist climate. Over the precipices descend great waterfalls, and after rain on all sides are innumerable smaller cataracts.

In most of the other fiords the scenery, while still grand, is of a somewhat gentler character than at Milford. There are many islands in some, and forest scenery is more prominent. Of these fiords, George Sound, Thompson Sound, Doubtful Sound (visited by the famous Spanish navigator Malaspina in 1791) and Dusky Sound are said to be the finest. The last named fiord is historically interesting to all New Zealanders on account of its having been visited by Cook in 1770 and 1773. With Cook on the second occasion was Vancouver, who in 1791 as commander of a British exploring expedition revisited Dusky Sound. The names Vancouver



LOOKING UP MILFORD SOUND FROM WINDBOUND POINT. (Photo by New Zealand Tourist Department.)

Island, Malaspina Glacier, and Cook Inlet on the far-distant shores of British Columbia and Alaska commemorate the names of the great seamen who were among the first to see the glories of our New Zealand fiords.

Over a century ago Dusky Sound became the headquarters of sealers, so that here the first settlement of New Zealand may be said to have taken place. Long ago, however, the sealers departed, leaving nature in undisturbed possession. While Dusky Sound and the other fiords still remain practically uninhabited the tide of settlement has set in almost everywhere else in New Zealand. It would appear that the fiord country will ever remain much as we see it now, but who knows? In years to come the utilization of its great water-powers may threaten the destruction of some of its beauties, even as Niagara is threatened today.

THE MAORI OF NEW ZEALAND.

A. Hamilton,

Director of the Dominion Museum.

On the arrival of the earlier European explorers and settlers in New Zealand, the country was found to be thickly inhabited with a bold and active population who had been in possession of the country for a period of at least four hundred years, and who during the whole of that time had been completely isolated from other centers of social and artistic development. Much interest attaches to a race which has been for so long a time absolutely free from contact with other people differing from them in manners and customs, and the progress of investigation into the habits and customs of the older Maori as they were at that time, brings to light a very complicated and well thought out scheme of political and social economics admirably suited to their environment and their level of civilization. They had much in their favor. The temperature in the North Island of New Zealand where the majority of the race lived, ranges within very moderate limits, and notwithstanding heavy rains and strong winds the climate may be classed as healthful. There are no pestilential or malarial regions of any kind. The surface of the islands is much diversified with lakes, mountains, rivers, volcanoes and other physical features, and with regard to the organic environment there is a great variety in the species of trees, plants and shrubs. The native whose palate was not educated to the refinements of modern civilization found amongst its edible productions, many plants bearing wild fruit, the fern with its fronds and its starchy root-like rhizome which furnished a substantial part of his daily food, and many trees yielding berries and fruit of edible kinds in their proper season.

The animal food available to the Maori was not so varied as that at the disposal of most other races, the only indigenous land mammal being a small rat which was very much appreciated as food. The dog which was used as food in certain ceremonies was certainly introduced in one of the earlier migrations. The birds and fish of the sea, rivers and lakes made up for the lack of sustenance for the hunter and agriculturist. The introduced plant foods, the *taro* and the *kumara* assisted by careful cultivation flourished extensively in the North Island. The result of their out of doors mode of life produced a very fine and well made race. There was a marked difference in physique and general appearance between the upper classes and those at the bottom of the social scale. There are some grounds for the idea that the slaves and the lower classes inherited racial characteristics from the people whom the Maori undoubtedly found in occupation of part of the Island on their arrival at the time of the great Heke or migration in the year 1340 or thereabouts, and who were probably of Melanesian type. With regard to their intellectuality they were very fond of novelty and very apt at taking up simple ideas and in copying the habits of foreigners if they desired so to do. From traditions and songs which have been handed down it is clear that many of them possessed not only considerable imagination but a remarkable power of memorizing the instruction in tribal history which was given by the priests who were in charge of the ancient knowledge of the tribe. It is not unusual to find a considerable amount of quiet wit and humor in the older people, and a well-placed joke or appropriate saying serves more than a threat in deciding an argument.

With regard to their social regulations, they were governed by their chiefs according to the laws of public opinion and according to the laws of tapu, which consisted in the higher classes, such as the chiefs and priests, setting aside things and places as sacred and protected by the gods; or prohibiting certain things to be done under ghostly penalties. The chiefs superintended the agricultural and building operations as well as the war expeditions that were carried out. There was a certain division of labor, the women attending to the domestic duties, the preparing of flax for the garments which they afterwards wove, and to the work of preparing the food. The men also took their full share of labor in making the large canoes, some of them being one hundred feet in length, richly carved and adorned with inlaid work, in building the houses and erecting the fortified strongholds, and all the really heavy work. The subject of agriculture received great attention amongst them and their operations were carried on at times and seasons regulated by the appearance of certain stars. The planting and the gathering of the crops were duly supervised by the tribal priest and the first fruits offered with due ceremony to the heavenly powers. The administration of justice as they understood it was conducted on the principle of compensation and retaliation, sometimes by the persons individually concerned, or, if the matter was of sufficient importance, by the tribe as a body. Their public opinion demanded a commercial equivalent for every offence except the destruction of life which required the life of the guilty party or some other person of the same tribe as the guilty party. This of course led to feuds and frequently to hostile expeditions of considerable importance. We hear a great deal in the records of Maori history, as we have it at the present time, of the constant and incessant warfare in which the Maori delighted. I am not at all sure that one is justified in representing them as constantly in a state of civil war. It is impossible for a people to be in a state of constant war and yet to bring to perfection laborious and complicated agricultural operations, which we know were carried out. Battle was no doubt taken great delight in by the Maori, mainly as a most desirable way of getting satisfaction for a real or pretended insult in a community where might was mainly right.

We read in the earlier accounts of the great number of people seen all along the coast and to support such a number much work must have been done in cultivating their crops and in peaceful pursuits. Although frequently described as savages they cannot strictly be called so. It would be absurd to say that the Maori was untaught or without cultivation of mind or manners, or a man of extreme, unfeeling, brutal cruelty, which is the dictionary definition of a savage. As a matter of fact much depends upon the standard adopted in viewing them. The better class of Maori in olden times was extremely ceremonious and possessed of an elaborate system of etiquette, and it is perfectly true even at the present time that he regards the average European as a man possessed of extremely bad manners from the Maori point of view. The head of the family was their priest as well as their leader in war. Certain of the higher rank were regarded as men specially possessed and trained in the wisdom of the ancients and it was their business to conduct the ceremonial functions such as the offerings made to the gods of the first fruits of

Old Maori Lady, Wellington.

the result of the agricultural operations or of the sea fisheries. They were also called upon to divine and ascertain the possibility of the success of war parties and tribal undertakings. It was also their duty to see the laws of tapu strictly enforced, to perform any ceremonies that might be required, to recite the incantations at certain times and seasons, and to instruct the young in the national traditions and songs, to combat the power of the evil spirits and of the rival tohungas of other tribes. It was also their duty to ensure proper proceedings relating to the crops and to memorize and to transmit to the next generation the pedigrees of their chiefs and families.

The treatment of disease was regulated by the idea that internal disease was caused by malignant spirits which had entered into the sufferer and had to be cast out. External injuries and disease were generally attributed to natural causes and were treated simply by the application of leaves and washes of various kinds.

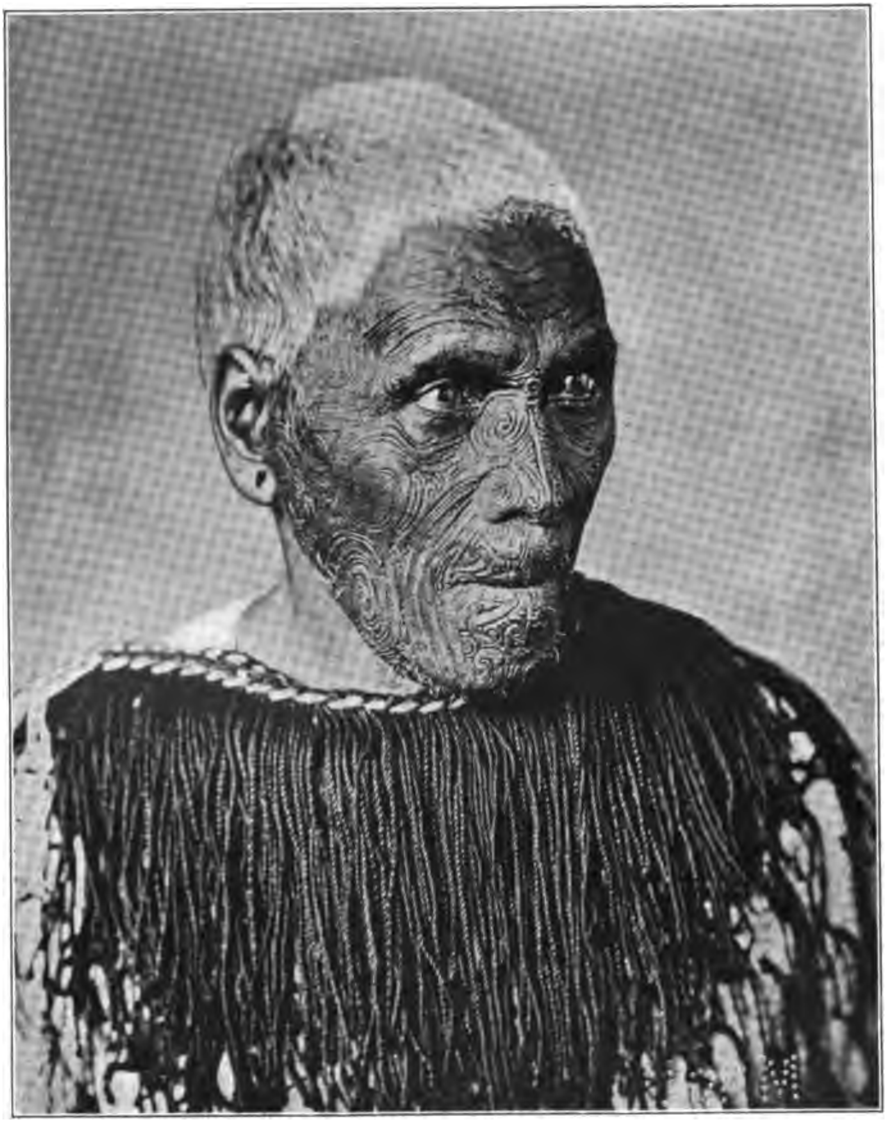
They had a satisfactory system of numeration depending upon an elaborate and somewhat complicated process. They divided the year into thirteen moons defined by the rising of the stars, the time of the flowering of plants, and the arrival of migratory birds, etc.

The Maori people, as a whole, being to a large extent dependent upon their acuteness of observation for their daily food, at one time knew, and had an intimate acquaintance with, the flora and fauna, but much of this knowledge is now forgotten. Their language was soft and euphonious and undoubtedly belonged to the great Polynesian group of languages. Several distinct dialects were found in the northern parts of the North Island by the early missionaries and settlers. Their mythological tales resemble those of the Pacific group and are of great interest to the student of mythology and of folk lore. Their divergences and intervariations are to be attributed to many causes, the absence or presence of conspicuous phenomena, climate and geographical position, the degree of intellectual endowment and the character of their civilization. In the midst of all the divergences we can still trace the action of the same human mind, the presence of the same mental lineaments that we find in widely scattered races. If the New Zealander fancies that the souls of chiefs are transformed into shining stars, it is no more than was thought by the ancients of the

Mediterranean shores. If the Maori believes in the fairy, giants and the little wood-gods it is no more than the fancy of the old English peasant who believes in the pucks and elves, whose midnight revels by a forest side or fountain he sometimes sees. The gods of the winds and oceans who occur in Hellenic and Roman fable, reappear like old acquaintances in the myths of the Isles of the South.

Even the imperfect evidence which still remains with us justifies the statement that the more gifted natives possessed that superior faculty—that conception of the natural and beautiful which has ever been found in the higher races of mankind. Ruskin has great praise for the worker with an individuality and contrasts the old Venetian worker in glass, with his profusion of design, his personality of purpose, and his love of art with the British worker with his mechanical accuracy. " Everything the old Venetian made was a separate thing—a new individual creation," but, he says, the British worker does things by the gross, and has no personal interest in any article. I am firmly convinced that, speaking comparatively, and according to their natural conception, the art of the Maori was of a very high standard. They had a fine perception of the beautiful, the regular, and the symmetrical, and they spared no pains or labor to produce a satisfactory result, and like the Venetian glass ware each work was a separate thing—a separate creation. Everything was made by an individual, and nothing was ever made for sale.

At the beginning of the eighteenth century all the authorities agree that the buildings then in use and the buildings falling into decay were covered with carvings and adorned with painted patterns and ornaments. The houses and buildings were much more substantially constructed than the majority of houses in other islands of the Pacific and were better designed and finished than the houses that would satisfy the requirements of the natives in warmer climates. In their adornment they used not only elaborate carvings in relief but also painted patterns on the rafters supporting the roof. These patterns are of considerable interest and were executed in three colors used by the Maori, that is black, white and red. They strove to attain the greatest purity and brilliance in these colors, and although the patterns themselves were strictly prescribed by custom, yet the artist contrived to have great variety



A Well-Tattooed Man.

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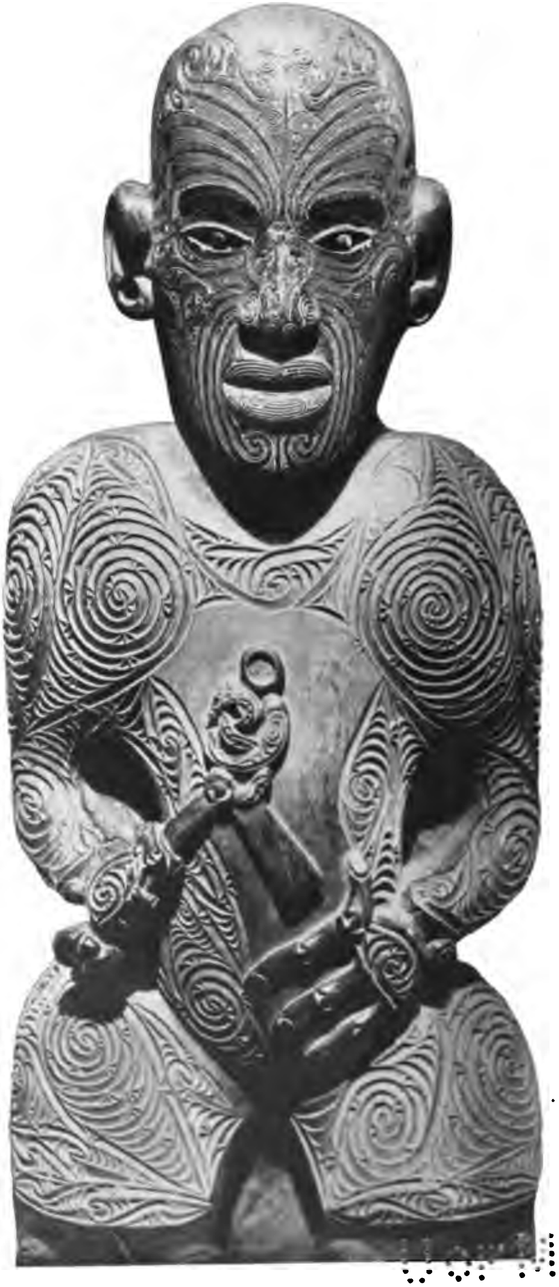
of execution, although all the developments were governed by fixed principles. Graceful curves and not straight lines were used in Maori designs. In the carrying out of his patterns the artist was to a great extent at the mercy of his material. A design which is perfectly suited to one material cannot be so well carried out in another. This is specially noticeable in textile fabrics which by their geometrical construction impose straight lines on designs which would by the ordinary methods be represented as curves. These are of course somewhat modified according to the coarseness of texture or mesh as in a very fine or close mesh curved lines may be very fairly suggested.

In the adornment of objects useful in every-day life, such as weapons, tools, etc., we find the ornamentation has been to a large extent influenced by the form or function of the ornament and it is usually admirably adapted to the latter. Not only do we find this to be general in the case of decorated implements, but it also holds good in the case of the beautiful designs tattooed upon different portions of the body, which amongst the Maori reach a very high pitch of artistic excellence. Here we may see excellent examples of the harmony of ornamentation with natural contours, the tattooed lines seem to express the natural features, and we cannot but admire the taste of the artist, even if the practice does not commend itself to our particular civilization. Their artistic taste is also observable in the preparing of flax for their garments and in their smaller personal ornaments: in the employment of the snowy plumes of the white heron in their head-dresses, in their use of the white muslin-like epidermis of the leaves of the mountain *tikumu* plant, and of the scraped and bleached white inner rind of the pimelea as a tie for their black hair: in the snowy-like tufts of the down of the albatross and of the gannet placed in their ears, to set off the more strikingly the lines of tattooing in their cheeks. And so with their other highly prized head ornaments, namely the tail-feathers of the huia bird tipped with white, the skin of the dark plumaged tui (or parson bird) with its strikingly contrasted hanging white neck-feathers suspended in their ears, and also the shark's white tooth (mako) for which as a contrast, they, whenever possible, obtained black ribbon. All this was entirely in keeping with their national taste before it became debased and vitiated: and in no case have I ever seen a Maori wearing a red or gaudy-colored ribbon to suspend his white ear-pendant of shark's tooth or his greenstone ornament.

Although I have seen very many of their old and ancient carved and ornamented staffs of rank, they were all decorated with white hair only, obtained from the flowing tails of their white dogs: and I never saw a staff ornamented with the hair of the tails of their black dogs. This could only have arisen as a matter of general taste, the white hair, when new, being a much greater contrast to the carved dark and stained wood of the staff than the black hair could be.

It has been stated that "Proverbs are before books," and it is quite true that much can be learned of the manner and customs of the people from the study of their proverbial sayings. A very large number have been collected and placed on record, and some curious incidental sidelights come out when these are classified and arranged. Those who do not know the old Maori well would be quite prepared to hear that there were many proverbs and proverbial sayings in favor of war, cruelty, anger, gluttony, sloth, laziness, lying, duplicity, and of superstition and omens, and of ill treatment of the lower classes, but it can be safely stated that these are not to be found amongst the proverbs of the Maori people, while on the other hand there are large numbers in favor of endurance, patience, deliberation, courage, and bravery, many against ill-temper, ill-manners, laziness, slander and cowardice. Naturally many of them were drawn very largely from nature and from natural phenomena.

They had a minute acquaintance with their country and its physical features. Every rock, cape and headland had its name. As an example as to how they applied their traditions to the physical features of the country it may be mentioned that in Otago there is a sandy bay on which are strewn many large globular septarian boulders. According to Maori ideas and tradition this was the scene of the loss of the Arai-te-uru, one of the canoes of the great Maori migration to New Zealand about three hundred and fifty years ago, as she was voyaging to the south in search of the precious greenstone or jade stone of Te Wai Pounamu. The reef of rocks which extends seaward near Shag Point represents the petrified hull of Arai-te-Uru. After braving the perils of the great ocean of



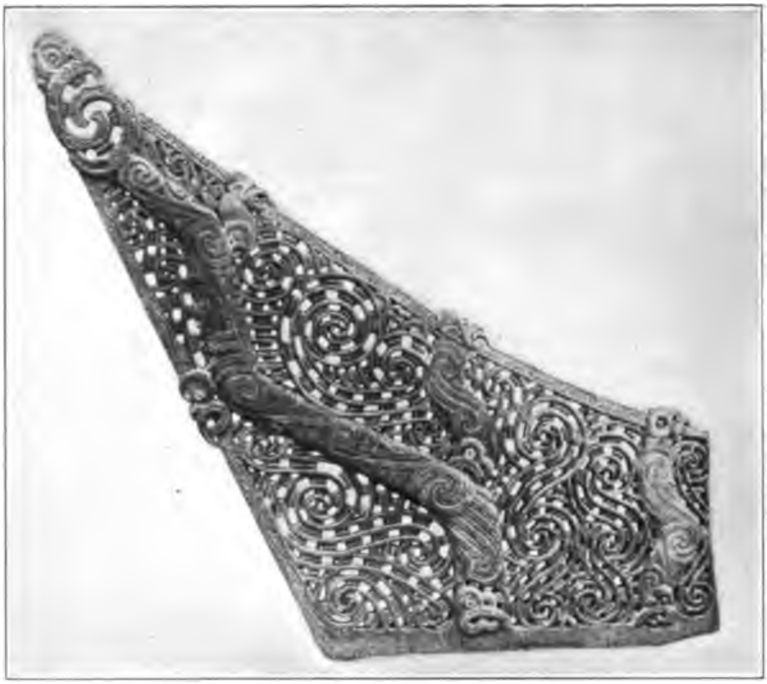
Carved Figure of an Ancestor.

Kiwa and the stormy waters of Raukawa, or Cook Strait, she here lies on her side with the empty hollow of her hull facing towards the mainland, while close to her, in the shape of a prominent rock, stands the petrified body of her commander. Strewn along the beach are some of the huge boulders representing the Hinaki or eel-basket of Hape-ki-taurake and the slave Puketapu. The more globular septarian boulders are the calabashes which held the supply of water for those in the canoe, and a number of strangely shaped irregular concretions further along the shore are the kumaras (sweet potatoes) washed ashore from the wreck. Evidently some of the crew reached land safely, for the surrounding hills bear their names. Towards the south lie two twin hills, Nga tamariki a Hekura (the children of Hekura) and Puketapu, who, while gathering firewood were overtaken and surprised by the dawn, and turned into hills. To the north of these stands Pakihiwitahi (the one-shouldered) with his face to the south and his single arm extended waiting in vain for the return of Puketapu and the children of Hekura. The traditions and stories relating to the other parts of the Islands are numerous and interesting.

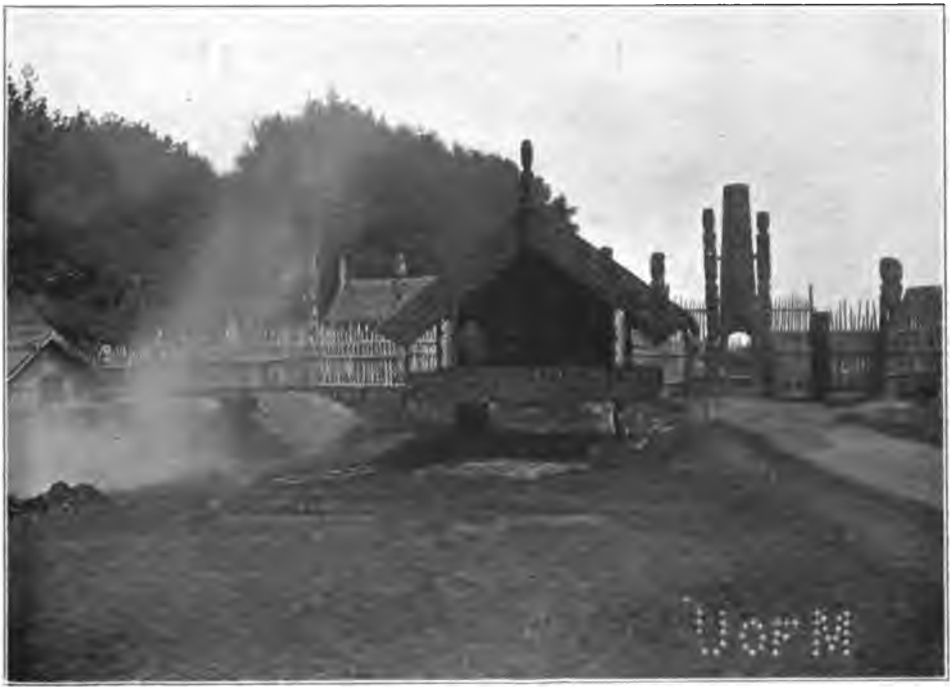
Nothwithstanding the warlike nature of the Maori it must not be thought that either in the North or South Island there was a continual state of warfare, and it is quite a mistake to suppose as some have done that the old Maori life in peaceful times was one of privation and suffering; on the contrary, it was a very pleasant state of existence; there was a variety and abundance of food and agreeable and healthy occupation for mind and body. Each season of the year and each part of the day had its specially alotted work both for men and women. The women besides performing such household duties as cooking their food and cleaning their dwellings, made the clothes and bedding required for their families. They gathered and prepared the flax and other fibers used, and worked them up into a great variety of garments, many of which were of a kind that took months to complete, and when finished were very beautiful specimens of workmanship. The men gathered the food and stored it in whata or storehouses built on tall posts to protect the contents from damp or rats. Besides such natural products of the soil as fern-root and other roots, they cultivated in the northern parts kumara, taro, hue, and karaka. Fish of various kinds were caught in the proper season and cured by drying in the sun. Wild pigeons, kaka, paradise ducks and titi (mutton birds) were cooked and preserved in their own fat in vessels made from kelp, bound round with totara bark to strengthen them. Netting, carving, grinding by friction, and fitting stone implements and weapons occupied the time of the old men and also much of the young men's time. They beguiled the winter evenings by reciting tales, myths, histories, traditions, and tribal genealogies, chanting and singing poetry, telling fairy tales, and performing dances. It was only when they became ill and when harassed by their enemies that the ancient Maori can with any truth be said to have been miserable or unhappy. They delighted in war when it arose, so that the danger and fatigue on such occasions were more a delight than sorrow or weariness.

Less than one hundred years ago only the Maori people occupied what we now know as New Zealand, and as already stated they had for some hundreds of years been entirely removed from outside influences. The first ships that appeared off the coasts were objects of great interest and were believed to be floating houses filled with spirits. It was not long, however, before those who landed were found by the Maoris to be in most points very mortal. The new comers were a great source of joy and delight to the intelligent and inquisitive Maori. The wonders that the strangers brought with them, their different clothes and all their equipment were new and of never-failing interest. The most valued of all were their possessions of iron, and one can scarcely imagine the delight of the Maori when he found a tool which would take a keener edge and last better than even his greenstone or his sharp glassy obsidian. Moreover the visitors were willing to give these much prized treasures for quantities of flax; and from a chief's point of view it was easy enough to order a quantity of flax to be scraped and prepared for the white man.

Time went on and trade began to arise between the Australian ports and some of the principal native settlements in the North Island of New Zealand. Whalers began to give place to storekeepers of various kinds who were attracted by the prospects of trade. Then came the missionaries who desired to bring such a noble race of people within the folds of their particular faith. The success of the missionaries was amazing. It was considered quite



Part of the Ornament on a Waikato War Canoe.

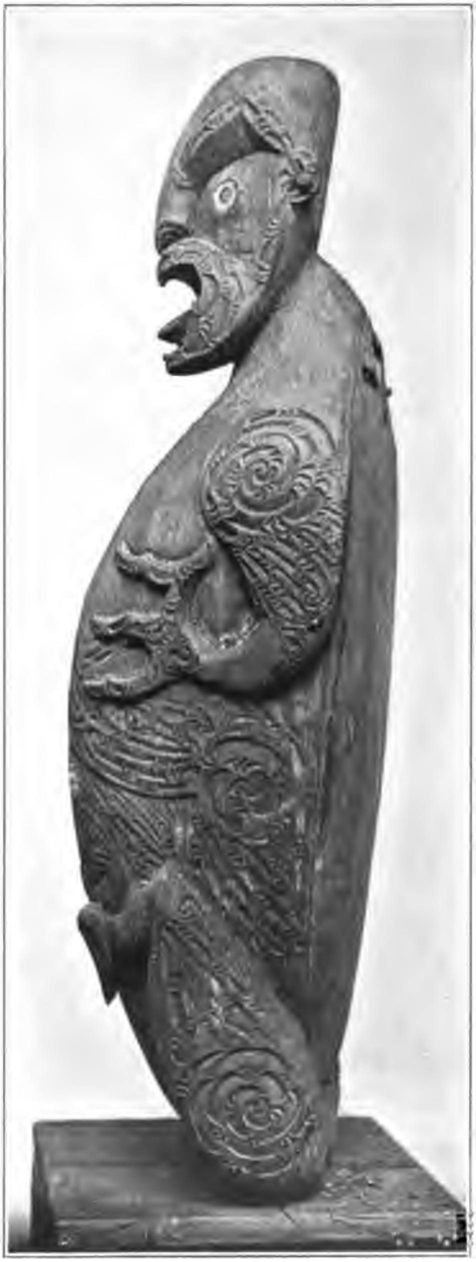


Carved Storehouse for Food in a Maori Village. Gateway into another portion of the village behind it.

the thing for every chief to have his own missionary, or if he could not have a missionary, to have a white man of some sort attached to the village, and the teachers found keen and willing students of all ages eager to drink of the new knowledge which was offered to them. Many important developments followed and colonization was attempted in a systematic manner by organized associations in England and other places. Land was purchased from the natives without much trouble and as a matter of fact the Maori never objected very much to selling the land as he never considered that it could be of much use as a personal possession. His idea of the value of land was based on its use to the community as a hunting and fishing ground and for cultivation of limited area.

As the news of the settlement of the country became known, further immigration took place and before long the natives themselves began to see that there would be very little room left for their own kith and kin. Disagreements as to the form of government to be introduced arose, and were fomented by mischievous individuals and for at least thirty years the country was handicapped in its progress by wars and disputes between the ever increasing flood of Europeans and the now fast diminishing natives. In the meantime the Maoris had been adopting European manners and customs. The power and authority of the native chiefs had diminished and the people had lost many of their old customs which were of the utmost service in consolidating the race and in keeping up the national spirit. During the troublous times the Maoris were divided into two parties, the one loyal to the European government and regulations, and the other opposing them. At the present time there has been peace in the land for many years and the younger generation of the Maoris are taking heart again and endeavoring to raise the moral and intellectual standard of the members of their race.

The number of natives at present in New Zealand, mainly in the North Island, is estimated at something over forty thousand. They have still remaining to them a considerable portion of their landed possessions, much of which they are unable or not willing to use themselves for agricultural or pastoral purposes, and much is leased to Europeans, the owners receiving the rental. Many schemes have been proposed for the better utilization of the Maori lands. Since the troublous period of the Maori war greater attention has been paid to the study of their history and of their art and it is now realized, that, as in other countries, much valuable and interesting history has been irretrievably lost. Only by making the greatest efforts at the present time without further delay can we hope to preserve for posterity any further records of their former civilization.



Burial Chest to Contain the Bones of a Distinguished Person, after the bones had been cleaned and prepared.

THE UNIVERSITY OF WISCONSIN MODELS.

LAWRENCE MARTIN.

ASSISTANT PROFESSOR OF PHYSIOGRAPHY AND GEOGRAPHY, UNIVERSITY OF WISCONSIN.

METHOD OF MODELLING.

The Geological Department of the University of Wisconsin has prepared four large relief maps or models during the past two years. Two of these are also geological maps. They have all been modeled under the writer's direction by any expert mechanician, Mr. E. H. J. Lorenz, who has devised many ingenious pieces of apparatus for model-making. These include a system of controlling location and relief by rectangular coördinates. A map is made of the same size as the proposed model, and is pinned upon a map board which has a graduated bar on one side. The model is made in a shallow box with a similar graduated bar. Points on the map are located upon the model with a T-square which runs on the graduated bar of first the map board and then the model box. This T-equare carries a slide with a vertical pointer by means of which the features of the maps are accurately transferred to the model. The relief features of the model, which is usually built of modeling clay, are measured by the vertical pointer, clay being added till the surface is built up to, or clay removed till a given point is cut down to the correct altitude. The model is finished by hand tooling, after which a plaster of paris-papier mache composition is poured into a wooden frame reinforced by chicken wire. The negative thus made may be used for printing as many copies of the model as are desired. The model is painted and lettered by a draughtsman.

A variation of the above method involves casting a preliminary plaster negative and model after blocking out the main features in the clay. Drainage may then be traced upon plaster surface by the use of carbon paper and the drainage systems cut into the plaster. For this cutting Mr. Lorenz has devised an ingenious drill run by electricity and cutting with the aid of appropriate tools the shapes of valleys, plains, etc. This drill may be moved anywhere on the model by a pivoted arm and elevations are controlled so that flat lake surfaces may be cut or regular grades of streams, etc. Elevations are built up where necessary on the clay surface as before. The original model is then reproduced by casting a negative from which reproductions of the model may be made.

MODEL OF THE LAKE SUPERIOR REGION.

This model (Fig. 1) includes the area bounded by the parallels of 44° and 49° north latitude and the meridians of 84° and 95° west longitude, an area of over 181,000 square miles. This is the same area covered by the new geological map soon to be published by the U. S. Geological Survey in connection with the monograph on this area by C. R. Van Hise, C. K. Leith and others. The model is based upon topographic maps by the U. S. Geological Survey, the state geological surveys of Wisconsin, Michigan, Minnesota, the Geological Survey of Canada, the Ontario Bureau of Mines, the U. S. Lake Survey, the Mississippi River Commission, and various railways, mining companies, etc. It is on a horizontal scale of 10 miles to the inch and a vertical scale of 3,600 feet to the inch, an exaggeration of a little over fourteen times the horizontal. It measures 5 feet and 10 inches by 3 feet and 8 inches, framed.

It shows the basin of Lake Superior and part of Lake Michigan and the headwaters of the Mississippi River and of the Hudson Bay drainage. Part of the Laurentian peneplain with its monadnocks is depicted, together with the belted plains adjoining, the topographic expression of the various Archean, Algonkian, and early Paleozoic rocks being shown. Parts of the Driftless Area and of the areas of older drift, of Wisconsin drift, and of deposits in glacial Lakes Agassiz, Algonquin, and Nipissing are included. The location of each of the Lake Superior iron ranges and the copper country is shown.

MODEL OF THE BARABOO RANGE OF WISCONSIN.

This model (Fig. 2) is 3 feet and 8 inches by 5 feet, framed, and is on a horizontal scale of 2 inches to the mile and a vertical scale of 4 inches to the mile. It is based upon topographic maps by the

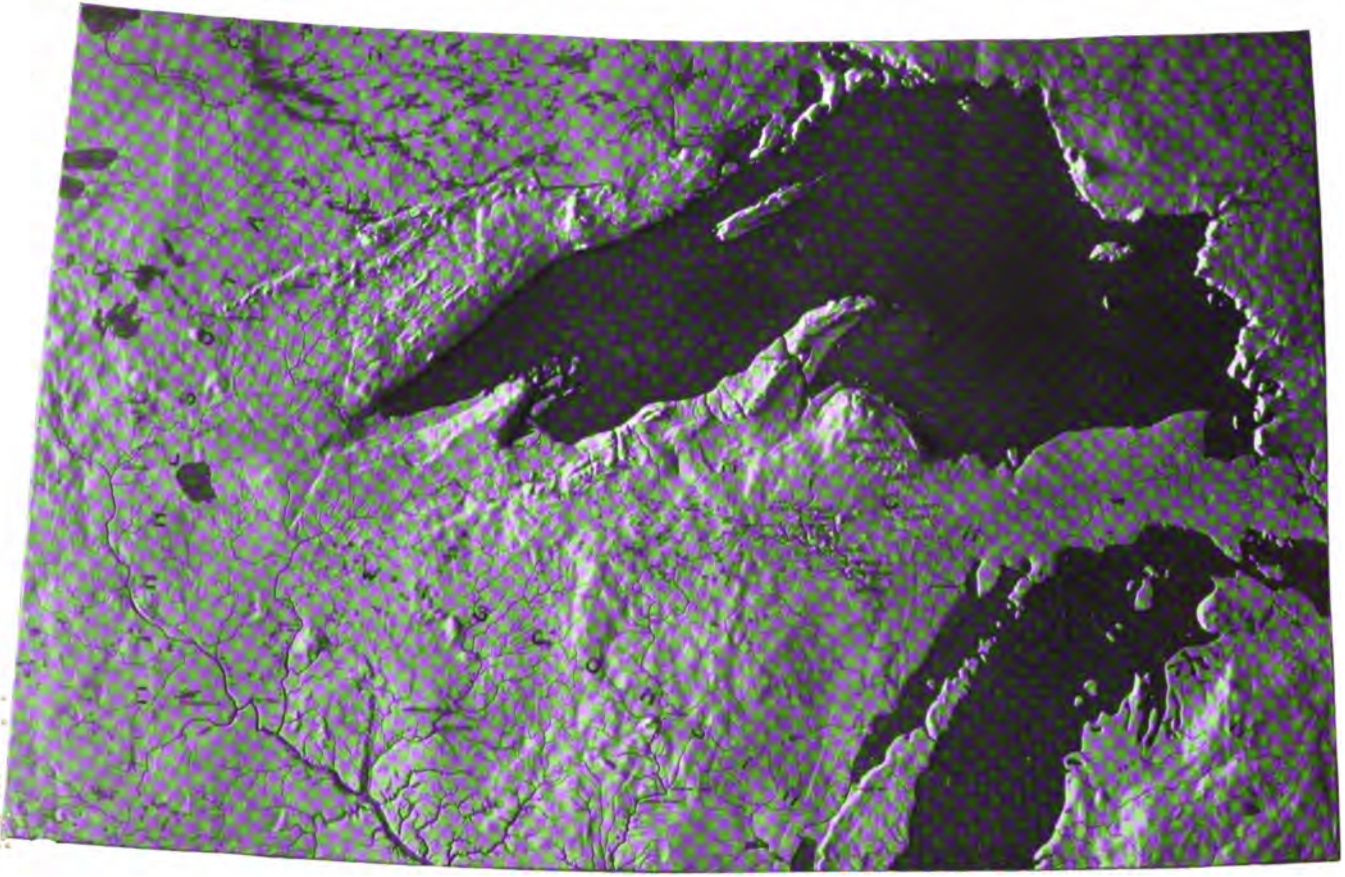


FIG. 1. THE MODEL OF THE LAKE SUPERIOR REGION.

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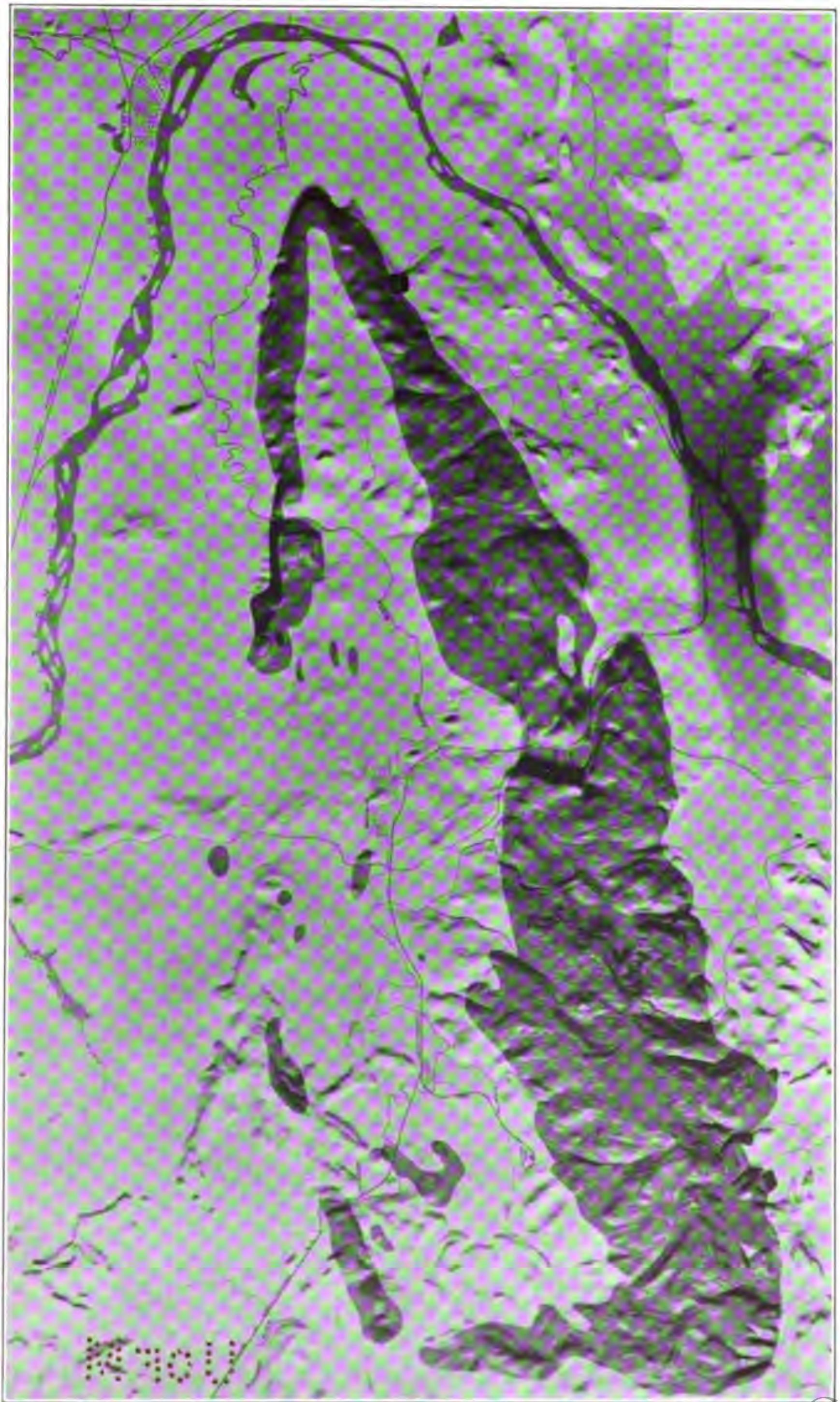


Fig. 2. The Model of the Baraboo District, Wisconsin.

U. S. Geological Survey, the geology being taken from the Wisconsin Geological and Natural History Survey. It shows the area described in Salisbury and Atwood's bulletin on Devil's Lake and the Dalles, and Weidman's bulletin on the Baraboo Iron-Bearing District, and includes the great bend of the Wisconsin River. The range is a monadnock of Huronian sediments rising above the Laurentian peneplain, covered by Paleozoic strata and now re-exhumed, standing out once more as a manodnock above a younger plain. Half of the range is in the Driftless Area, the other half, showing parts of the terminal moraine, in the area of latest glaciation.

MODEL OF THE MALASPINA GLACIER REGION, ALASKA.

This model (Fig. 3) shows the Malaspina Glacier, and the adjacent region near Mount St. Elias and Yakutat Bay. It includes about 7,350 square miles in Alaska and Canada, near 60° N. latitude, and 140° W. longitude. On this model whose vertical and horizontal scales are the same (1:80,000), about 1¼ mile equals 1 inch. The model is about 6 feet 3 inches by 4 feet 9 inches, framed.

It is based chiefly upon maps, photographs, and descriptions by I. C. Russell, and the Boundary Commission, as well as the work of Lieutenant Schwatka's *New York Times* Expedition, H. W. Seton-Karr, William Libbey, the Topham Expedition, George Broke, the Canadian Boundary Commission, H. C. Brabazon, the Duke of the Abruzzi, Vittorio Sella, H. G. Bryant, C. E. Hill, the Harriman Expedition, G. K. Gilbert, Henry Gannett, the U. S. Fish Commission, the U. S. Coast and Geodetic Survey, the U. S. Boundary Commission, Fremont Morse, the U. S. Geological Survey, A. G. Maddren, R. S. Tarr, Lawrence Martin and others.

Over two months were required and about 625 different photographs and a number of maps and charts, including some unpublished materials, were used in making the original clay model from which the plaster-papier mache reproductions are made.

The model shows a portion of the lofty St. Elias range whose snow fields cover everything above 2,500 to 3,000 feet, whose slopes permit. From these snow fields innumerable glaciers extend down the valleys, in several cases reaching the Pacific Ocean, Disenchantment Bay or Russell Fiord, and discharging icebergs. One great group of these valley glaciers has united at the foot of the mountains in a piedmont glacier—the Malaspina Glacier—whose area exceeds 1,500 square miles. Most of this area is clear ice, but where parts of the border are stagnant they have been covered by ablation moraine upon parts of which forests have grown. This is the largest glacier in the world outside the Arctic and Antarctic regions.

The east half of the model shows a series of fiords with cirques, hanging valleys, etc., produced by ice erosion when the glaciers were more extensive, as well as the glacial coastal plain known as the Yakutat Foreland. Marginal lakes, medial, terminal and recessional moraines and outwash plains are shown.

The region is especially interesting because of the original studies of this piedmont glacier and its surroundings by the late Professor I. C. Russell, and because it includes the origin of the Yakutat Bay earthquakes of 1899 during which there was faulting and shorelines were differentially uplifted. Subsequently the east portion of the Malaspina Glacier and several adjacent ice-tongues have begun the most extensive glacial advance of historic times.

MODEL OF THE STATE OF ILLINOIS.

This model (Fig. 4) was made for the Geological Department of the University of Illinois. It is on a horizontal scale of 5 miles to 1 inch and a vertical scale of 1,320 feet to 1 inch. The model is 6 feet 7 inches by 3 feet 9 inches, framed.

The topography is based upon the contour maps prepared in 1892 under the direction of Professor C. W. Rolfe, of the University of Illinois, for the Chicago World's Fair and upon the Topographic maps of the United States Geological Survey, the Mississippi River Commission, etc. The geology is mostly from the geological map prepared by Professor Stuart Weller, of the University of Chicago, for the Illinois Geological Survey.

The model shows the rather low relief of the prairie region between the Mississippi and Ohio Rivers and Lake Michigan, diversified by the low terminal and recessional moraines of the continental ice sheet, described by Professor Frank Leverett of the University of Michigan in his monograph on "The Illinois Glacial Lobe." In

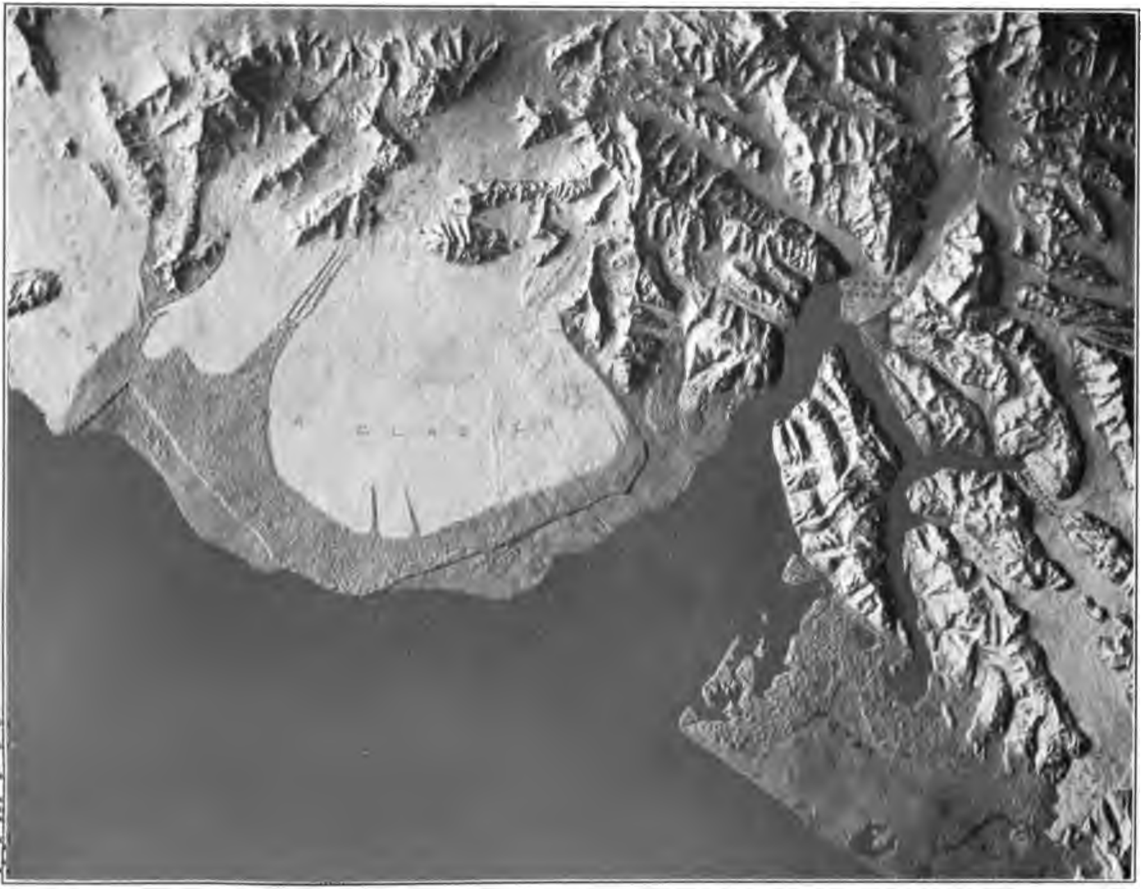


FIG. 3. THE MODEL OF THE MALASPINA GLACIER REGION AND YAKUTAT BAY, ALASKA.

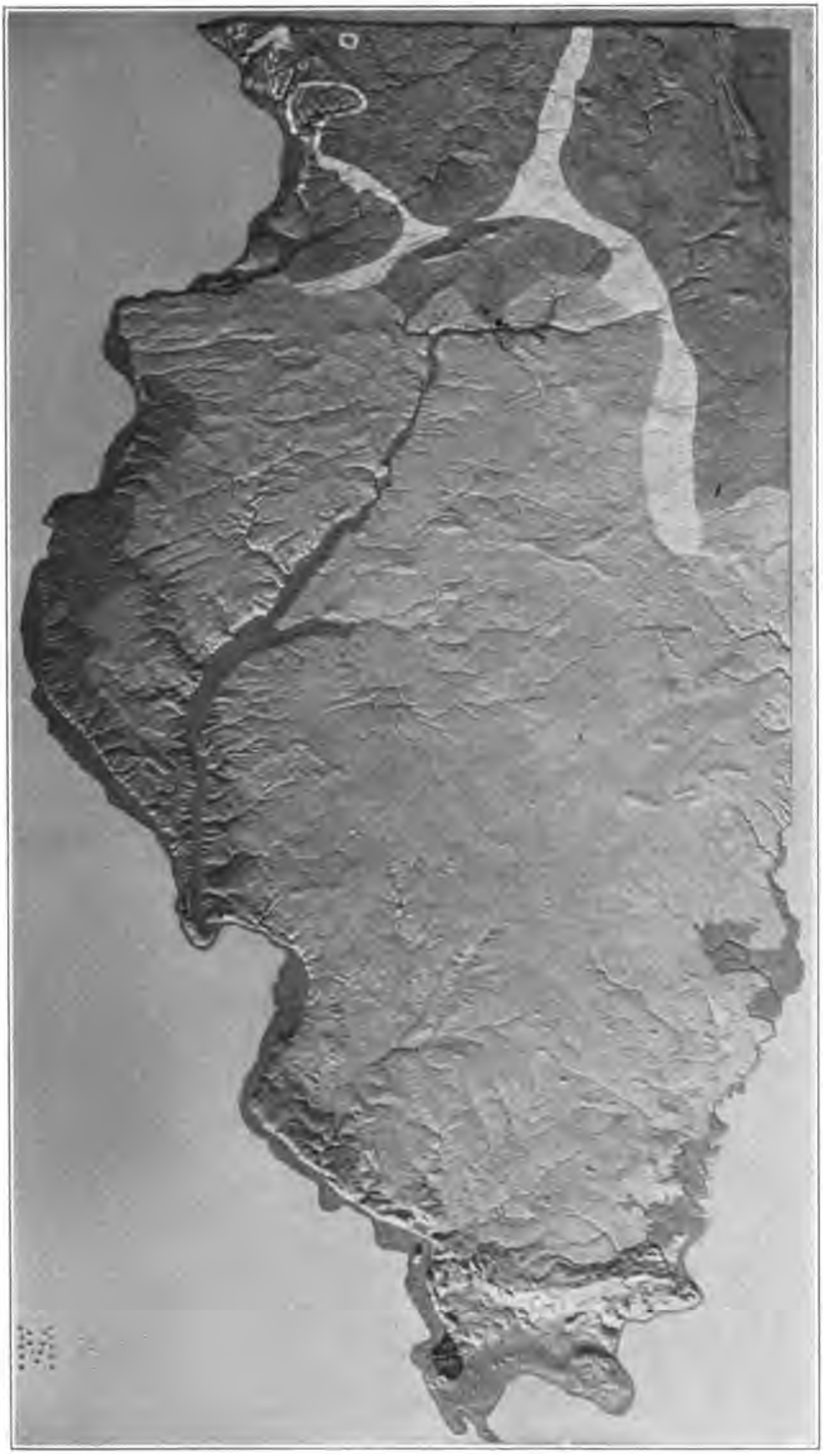


Fig. 4. The Model of the State of Illinois.

contrast with this there are sharply incised stream valleys and gorges in the lead and zinc district of a portion of the Driftless Area in northwestern Illinois, in the west part of the state along the Mississippi and Illinois rivers, and in the extension of the Ozark plateau in the extreme south end of the state. The bottom lands of the Mississippi and Illinois river flood plains form a third contrasting type of topography.

A model of the State of Wisconsin is now being made by Mr. Lorenz for the Geological and Natural History Survey.

GEOGRAPHICAL NEWS AND NOTES

Professor D. W. Johnson, of Harvard University, has prepared a series of lantern slides especially designed for use by teachers of physical geography. Each slide reproduces a photograph and a contour map of the same topographic feature, the map being so oriented that its bottom is the foreground of the photograph. The slides are intended to illustrate a variety of land forms, and at the same time to familiarize students with the contour representations of such forms. Among the features illustrated are stream valleys in different stages of development, glaciated valleys, cliffs of differential erosion and fault-line cliffs, block, folded and dome mountains, young and mature plateaus, volcanic cones and necks, trap ridges, drumlins, beaches, drowned valleys, uplifted and dissected peneplains. The slides are manufactured under the direction of Professor W. H. Lawrence, Massachusetts Institute of Technology, Boston. Any one can secure a descriptive catalogue of the slides free, upon application.

An interesting turn has appeared in Alpine circles from the information sent to the press by Mrs. Fanny Bullock Workman to the effect that last July she had engaged a party of competent French topographers to determine the height of Mount Huascaran, Peru. It was one of the twin peaks of this mountain which Miss Annie Peck claimed to have ascended in 1908 to a height of approxmately 24,000 feet. Mrs. Workman reports that the topographers carried out a careful survey from the sea coast to Yungay, and by actual measurement established levels at four stations from which they triangulated the two peaks of Huascaran. As a result of these measurements it appeared that the north peak has an altitude of 21,812 feet, and the south peak, 22,187 feet. These observations, therefore, make Aconcagua, 22,900 feet, still the highest peak in South America, as has been generally maintained by the majority of leading Andean explorers.

It is currently reported that a German expedition is to be formed to seek the South Pole. With preparations for Captain Scott's expedition well under way, and with the prospect that an American expedition will start within the year, the race for the South Pole promises to be much keener than the rivalry which ended in the discovery of the North Pole by Commander Peary.

The *Bulletin of the American Geographical Society* (January, 1910), reprinted from the *Journal of the Scottish Meteorological Society* an excellent summary of the nature and results of the meteorological researches in the free atmosphere, which have been carried on during the past few years. In brief the article deals with the work done by means of (1) kites, (2) manned balloons and (3) "sounding" balloons, equipped with self-registering instruments. This work of investigating the conditons in the upper atmosphere represents one of the most important phases of modern meteorological study, the chief results of which have now been collected for the first time.

An interesting discussion of the Hudson Bay route from western Canada to Europe is contributed to the *Scottish Geographic Magazine* (February, 1910), by Robert Bell, of the Canadian Geological Survey. The author points out the significant facts that this route has been used for more than 200 years by the Hudson Bay Company, and was always regarded as the easiest and most direct route to the Canadian Northwest. The delay in developing the route for commerce he ascribes to the early sparseness of population in the western provinces, and also to the disinclination of the people of the older sections to let this trade slip away from them after the expense incurred in the purchase of the territory from the Hudson Bay Company and in the construction of the Canadian Pacific Railroad. The open season, at Churchill Harbor for example, averages four and a half months and might be lengthened by artificial means, consequently little weight is to be given the popular supposition that the climatic conditions make an insuperable obstacle. Not only is the sea route entirely feasible, and more advantageous than any other, from the standpoint of reachng European markets from northwestern Canada, but also it is pointed out the railroad connecting Churchill and Winnipeg might be operated very economically by hydroelectric power, developed from the falls and rapids in the Churchill and Nelson rivers and their tributaries.

It is announced that Captain Scott's Antarctic Expedition will be granted $100,000, by the British government, or approximately one half the estimated cost of the expedition. This grant assures the departure of the expedition in July next for its base at Christchurch, New Zealand, from which the start southward will be made in December.

In an account of the Hispar Glacier published in the *Geographical Journal* (February, 1910), Mrs. Fanny Bullock Workman describes and gives a photograph of an unusually large glacier-table—the rock boulder measuring over 16 feet in length, the pedestal over 12 feet in height, and the whole table 18 feet from base to top.

The Royal Geographical Society has decided to award to Commander

Peary a special gold medal in recognition of his work in Arctic exploration and discovery of the pole. A silver replica of the medal has been voted to Captain Bartlett.

It is announced in *Petermann's Mitteilungen* that Captain Amundsen has modified his plans to the extent of postponing his departure from Norway until July, 1910, and his entering the Arctic until August, 1911, spending the interim in oceanographic investigation in the south Atlantic.

The February number of *Popular Science Monthly* contains two articles devoted to accounts of the modern work in marine biology and oceanography. The first, by Prof. C. L. Edwards, gives an illustrated description of the Swedish marine station at Kristineberg, where the study of marine zoölogy has been carried on for over three quarters of a century. The second article is devoted to the Berlin Museum für Meereskunde, opened a few years ago, for the purpose of illustrating everything concerned with oceanography.

An extremely interesting study of the sources of human food supply was contributed to *La Geographie* (Vol. XX, Nos. 4 and 5) by Prof. A. Woeikof. Two of the chief points made are, first, that the substitution of any manufactured substance in place of vegetable food is extremely improbable, for the reason that plant life is capable of storing solar energy in a much more economical manner than is possible in any machine; and second, that practically no one article of food is universally regarded as a necessity of life, whereas many kinds now regarded as necessities in one place or another were entirely unknown to those people a few decades ago.

After an examination of geographical and economic conditions, the author concludes that meat in the future will gradually become so expensive as to be practically unavailable as ordinary food, and that consequently the supply of food must sooner or later be drawn from the vegetable kingdom. This fact, however, offers no cause for alarm to Professor Woeikof, since he believes that the application of scientific methods of agriculture will increase the productivity of farm lands to an unlimited extent.

The *Journal of Geology* (January–February, 1910) contains an interesting description of the nitrate deposits of Chile. The chief points covered are the location of the deposits, the history of the nitrate industry, the mode of occurrence and composition of the nitrates, the origin of the deposits, the industrial feature of nitrate mining, and the location of deposits outside of Chile. In discussing the origin of the deposits, the author, R. A. F. Penrose, outlines a number of hypotheses advanced to account for the presence of the nitrogen, and concludes that its derivation from organic matter, especially from guano, is the most plausible.

ACTIVITIES OF THE SOCIETY

THE HOLM-NESTORIAN EXPEDITION TO CHINA.

BY

MR. F. V. HOLM.

The January meeting of the Society was devoted to an address by the Danish explorer, Mr. F. V. Holm, who gave an account of his expedition to secure the so-called Nestorian Stone. This ancient relic represents a monument erected to the efforts of the Nestorian missionaries who visited China in the early centuries of the Christian era. Mr. Holm discussed the history of the stone, and the many difficulties which beset his attempt to secure the original. In this he was unsuccessful, however, and was forced to be satisfied with a carefully made replica, which is now to be seen in the Metropolitan Museum in New York.

THE UNTAMED GIRDLE OF PALESTINE.

BY

DR. ELLSWORTH HUNTINGTON.

At the February stated meeting of the Society Dr. Ellsworth Huntington, of Yale University, gave a very interesting lecture on some of the results of his recent expedition in Palestine. He described in particular the conditions in the land of Judea, about the Dead Sea. and in the plateau of Moab. The conditions in these places at present were contrasted with the conditions as they are described in sacred history, the differences indicating great secular changes in the climate, especially with respect to rainfall. An additional set of evidences in favor of this conclusion appeared in the history of various cities in Palestine and the adjoining districts, where once important centers are now surrounded by practically uninhabitable desert. The case of Palmyra was perhaps the most striking of these. The results of the expedition supplement to a marked degree evidences of a similar nature found previously in other parts of Asia.

A GLIMPSE OF SOUTH AMERICA.

BY

MISS LAURA BELL.

The March meeting of the Society was addressed by one of our own members, Miss Laura Bell, who gave a very entertaining account of her recent visit to various South American localities. The speaker gave many intimate glimpses of South American life, especially in the great cities of the east coast, in some of which contrasts were drawn not entirely to the credit of the cities in this country. The charm of a South American town was set forth in such a way as to obscure the discomforts and difficulties encountered, which would indeed be much more than well repaid by the objects of interest. A large number of well-chosen illustrations supplemented the lecture.

Intermonthly Meetings.—This year the intermonthly meetings have been devoted to talks on South America by various members of the Society. Among those who have spoken so far are Miss Dora Kean, on "Chile." and Mr. E. Tyson Hutchins, on "Cuzco: the City of the Sun." Every meeting has been attended by a large proportion of the members of the Society, attesting the growing popularity of this phase of the activities of the Society. The reception committee have introduced the idea of light refreshments and an informal reception in the Society rooms following these meetings, thus providing a social occasion which has met with unstinted approval from all sides.

Change in By-laws.—It is proposed to change the by-laws of the Society in such a way as to permit the award of the Elisha Kent Kane Medal at times other than the stated May meeting, as has been the case heretofore. This change will make it more readily possible in the future to award the medal to the recipient in person, since in the case of award to foreign explorers, the former restrictons in regard to date of award, usually necessitated award by proxy.

Spring Excursions.—It is understood that the excursion committee are planning a number of spring excursions, announcement of which will be made at an early date.

BOOK NOTES AND REVIEVS

Davis, W. M. *Geographical Essays.* Pp. 777. Edited by Douglas Wilson Johnson, Harvard University. Ginn & Company, Boston, 1909.

Under the above title the editor has collected the most important of the geographical essays written by Professor Davis during the last twenty years. All these essays have been printed before, but they were scattered through so many different publications as to be more or less inaccessible to many students of the subject; their collection, therefore, in a single volume will be welcomed by all workers in geography.

In collecting the essays, the editor has grouped them under two heads, first, those of educational character and, secondly. those dealing with physiographic subjects. These two phases of the subject of geography represent the fields in which Professor Davis has been most active, and in which his contributions to geographical science have been most numerous and valuable. For these reasons, apparently, it has been possible to include only representative essays from among the many which have appeared in the last two decades. There are some essays which one might wish to have included in the volume, but in general the editor has selected those of chief value to most readers. A bibliography of the author's essays, not here included, would have been a useful addition to the volume.

Chile: A Handbook. Pp. 236. International Bureau of American Republics, Washington, D. C.

This volume is decidedly valuable as a handbook of information about Chile, and despite the concentration of facts, many portions are very interesting reading, if anyone desires to get a clear idea of Chile as a country.

From the standpoint of the average individual the portions most likely to prove attractive are the chapters on the general geography of the country, the different provinces and their resources, agriculture, mining, manufacturing industries and commerce. These six chapters give a very clear notion of the resources of the country, its opportunities and prospects—the particular kind of information which is useful to anyone contemplating business relations with the country. Even the casual reader will be convinced that in many lines Chile offers excellent opportunities for American enterprise.

The book is excellently illustrated with a profusion of photographs, which in themselves are calculated to create quite a new impression of Chile. A good map and an elaborate index help much to make the volume usable.

Bernier, J. E. *The Cruise of the Arctic.* Pp. 127. Ottawa, 1909.

This volume represents the report of the Canadian governmental expedition to the Arctic Islands and Hudson Strait, undertaken by the ship *Arctic* 1906–1907. In general the report is given over to the official presentation of the commanding officer's log of the voyage, presented in the form of daily records of work done.

The meteorological data collected in the appendix is valuable and interesting, especially in a comparison of the relations between different wind directions and other meteorological phenomena in high latitudes.

It is also interesting to note Captain Bernier's prediction that the end of the Arctic whaling is near unless some protective measures are adopted to prevent extermination of the whales. No less significant is his recommendation that it is of the utmost importance for the Dominion to "take possession of all northern regions as far north as the North Pole," because those regions "abound in valuable islands which contain vast quantities of coal and other minerals."

Woodward, W. H. *Expansion of the British Empire.* Pp. 344. G. P. Putnam's Sons, New York, 1909.

As a history of the growth of the British Empire, this book is designed to meet both the severe test of classroom use, and the less exacting requirements of a generally readable book on the subject. It is sufficiently detailed to serve the purpose of most students of British history, but by emphasizing important controlling influences more than specific, and unimportant, incidents, it gives a narrative sufficiently connected to be readable.

Unlike most books dealing with this field the present volume devotes a generous amount of space to a consideration of the American colonies and their loss by the mother country. In this respect he makes it possible readily to consider the status of the British Empire, with respect to existing problems and the prospect for continued unity.

Walbran, Captain J. T. *British Columbia Coast Names.* Pp. 546. Government Printing Bureau, Ottawa. Canada, 1909.

The origin of place names is always a subject of interest to the geographer and explorer; in many cases, however, the origin is unknown through absence of records. It was with a view to preserving such records that the author undertook this difficult task of running down the origin of all place names on the coast of British Columbia. The number of names appearing on the accompanying map is sufficient indication that the author's task was not easy nor short.

In securing the records from one source or another, with their verification wherever possible, the author has not only uncovered much of the unwritten history of the exploration of the region, but has also frequently been led into the interesting fields of native folk lore and tradition.

CLIMATE AND MAN IN PERU.—I. The Coast.

Dr. Lucy L. W. Wilson.

"For when it is summer on the mountains, it is winter on the coast—it is truly a strange thing to consider this great difference in the same country. What is still more worthy of note is, that you may start in the morning from a country where it is raining, and, before vespers, you will find yourself in another, where it never rains."—"Travels of Pedro de Cieza de Leon," 1532–1550, translated by Sir Clements R. Markham.

Peru has ever been the land of romance. And, although her history stretches backward a thousand years before the Christian era, not even yet has age withered the infinite variety of her charm. Now, as then, in the midst of one of the most arid deserts of the world are oases of such wonderful fertility that on them both cotton and sugar are perennial. Indeed time has deepened many of the contrasts. The *arriero* and his knitting wife still lead their llamas, each laden with the old-time burden of a hundred pounds, from the Sierra to the coast. But now the llama trail is paralleled, not superseded, by wonderful railroads. One of them pushes up the mountain with four per cent. gradients and a three hundred and fifty-foot radius of curves.

Now, as then, the forest shelters the Inji-Inji Indian whose entire language is represented by the one word which gives them their name, but now, in addition, in the same forest there is at least one village, Astillero, on the Tampopato tributary of the Amazon, lighted by electricity and with telephone connection with the Sierra above, as well as the only wireless telegraph stations in tropical forests, viz., those on the line from Porto Bermudez to Massisea.

And her present history, the development of her still marvellous treasure house, is as full of interest and excitement and charm as the stories of her at least four successive civilizations although each one of these represents the greatest development ever reached by the Indian, a fact undisputed even by the iconoclastic Bandelier.

It surpasses even the romantic story of the Conquest by the ex-swineherd, the great, though illiterate, soldier Pizarro, or its colonial glories, or its war for independence, or its later brave though ineffectual struggle with its southern neighbor, Chile.

Peru has the advantage of every climate,—from that of eternal snow to that of tropic heat, from perpetual rain to rainless deserts. Probably no other country in the world, therefore, can better illustrate the control of climate over the life of man. Yet even here, while it is apparently the most important of the geographic facts in the development of Peru, it is only one of them. Moreover, it must never be forgotten that geography is not the only fact. Psychology is another.

"It takes a man to move the masses." The story of Manco Capac and Mama Ocella is not a mere legend. It was a man and a woman, as well as a favoring geographical environment, that taught the ancient Peruvians the arts of agriculture and weaving. It was the leadership of Tupanqui, as well as the stimulating climate of the Sierra, that made it possible for the Incas to conquer the at least equally civilized people of the rich coast valleys. The glory of extending the empire, if one may call it so, to the north rightfully belongs to Huayna Capac. Pizarro gave this treasure house to Spain. After the war of independence and a long period of civil strife it was another great man who brought peace and progress to an almost exhausted nation. Balta and Meiggs and Grau and Pardo and Carceres and many others have been quite as efficient as the geographical factors in the development of Peru. But they have been more transient. The "Great Man" has borne various names, whereas the geographical factors have been constant, unalterable, efficient.

Let us consider them.

Peru has been divided topographically into three regions: (*a*) The coast plain and slope, (*b*) the "Sierra" or plateau region, (*c*) the "Montana," or Amazonian slope.

These three regions have each of them equally distinct climates, and, in consequence, a distinct fauna, flora, civilization and history.

THE COAST ZONE.

The coast zone, stretching from about 3° 45′ S. to 18 S., may be conveniently divided into two regions: (*a*) A sand plain some 1,400 miles long and generally less than 100 miles broad; (*b*) foothills and the western slope of the Andes.

The coast zone is a desert region.

Perhaps no better description of this region and its climate has ever been written than that of the adventurous, indomitable, young yet accurate observer, Cieza de Leon. His journal, begun in 1541, thus explains itself:

"Ofttimes when other soldiers were reposing, I was tiring myself by writing. Neither fatigue nor the ruggedness of the country, nor the mountains and rivers, nor intolerable hunger and suffering, have ever been sufficient to obstruct my two duties, namely writing and following my flag and my captain without fault."

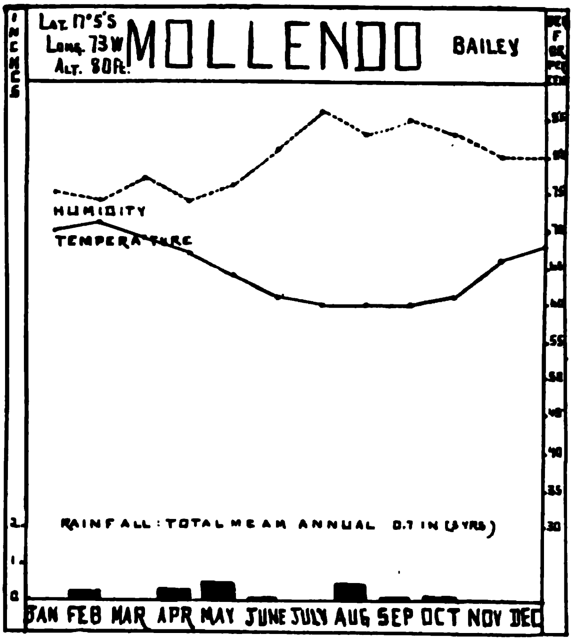
The following paragraphs, while not continuous, all describe about the same region:

"From Tumbez towards the south, the coast is without trees, and if there are any hills they are naked and rocky. The rest of the coast is a sandy desert.

"All the coast from this point [Lima] is low, though in some parts there are naked chains of rocky hills, and the whole is a sandy desert on which it has never rained, nor does anything fall except a thin mist; but I shall treat of this admirable secret of nature further on.

"What they call winter on the coast is nothing more than the season when clouds arise, which look as if they were charged with plenty of rain, but nothing comes of it save a drizzle so light that it barely damps the ground. It is a strange thing that though, as I have said, the heavens are well charged with clouds, yet it does not rain more than these slight showers. At the same time, some days pass during which the sun is not seen, being concealed by the thickness of clouds. As the mountains are so high and the coast valleys so low, it would appear that the former attract the clouds to themselves without allowing them to abide in the low lands. And when it is the natural time for them to rain it falls in the mountains, while there is none in the plains, but on the contrary, great heat; on the other hand, light showers fall on the coast when the region of the mountains is clear and rainless.

"There is another curious thing, which is that there is only one wind on this coast, and that is from the south; and although the wind from that quarter is moist and attracts the rain in other countries, it is not so here, and this wind prevails continually along the coast as far as Tumbez. I do not know the natural reasons for these things, but it is clear that this sterile rainless region extends from 4° south of the equinoctial line to beyond the tropic of Capricorn. This land of the coast of Peru is hot and dry while on either side it rains. I have gathered all this from what I have myself seen, and he who can assign natural reasons for these things, let him do so, as for me, I have said what I saw, and can do no more."



I. Mollendo is on the coast. Notice the slight rainfall and high humidity due to this fact.

The chronicles of Cieza de Leon are delightful reading. One may enjoy their flavor to the full without wishing, in passing, that instead of impressions he had given us facts. For the facts have been given us elsewhere in the terms of modern science, with tables and graphs based on accurate readings of exact instruments.

It is interesting to remember that the Boyden bequest for the erection and an equipment of an astronomical observatory for the observation of southern skies led to the taking of numbers of meteorological observations in various places in Peru, beginning in the year 1888 and continued beyond the selection (in 1891) of Arequipa by Professor Pickering, of Harvard, as the best site for such an observatory. Two volumes of these observations have been published (Annals of the Astronomical Observatory of Harvard College, Vol. 39, parts 1 and 2; Peruvian Meteorology, 1892–5; Vol. 49, Parts 1 and 2, 1899–1908). Two of the meteorological stations are in the coast zone: (*a*) Mollendo, alt. 80 ft., long. 73° W., lat. 17° 5′ S.; (*b*) La Joya, alt. 4,140 ft., long. 72° 30′ W., lat. 16° 46′ S.

The subjoined graphs picture the facts with reference to rainfall, relative humidity and temperature of these two stations.

HUMIDITY AND PRECIPITATION.

The humidity curve for Mollendo shows a very decided rise during the winter months. Similar observations made at any of the coast towns from Tumbez southward would doubtless give a similar curve. These are the months for the heavy mists (*garuas*) characteristic of the whole coast region. To them is due that suggestion of greenness which one observes, for example, over the, at first sight, bare brown steep sides of St. Cristobal, near Lima.

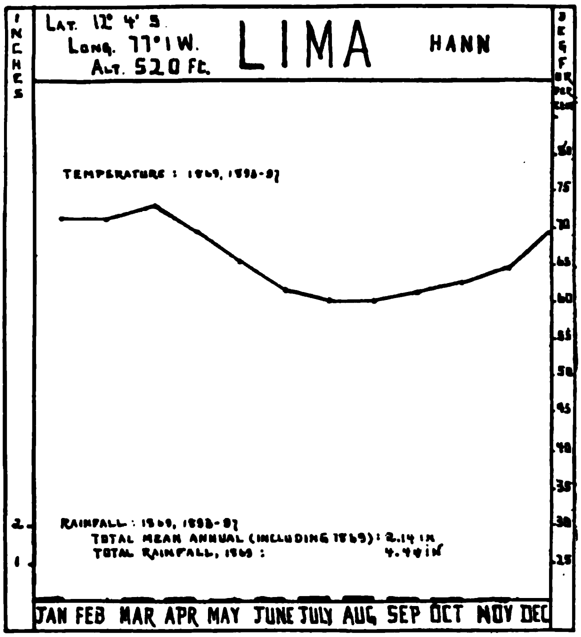
Both Mollendo, and La Joya are in the regions of the southeast trades. Why these are here dry winds is picturesquely explained by Maury in his "Physical Geography of the Sea."

"Finally they reach the snow-capped Andes and here is wrung from them the last particle of moisture that the very low temperature can extract. Reaching the summit of that range, they now tumble down as cool and dry winds on the Pacific slopes beyond. Meeting with no evaporating surface, and with no temperature colder than that to which they are subjected on the mountain tops, they reach the ocean before they again become charged with fresh vapor, and before, therefore, they have any which the Peruvian climate can extract. The last they had to spare was deposited as snow on the tops of the Cordilleras to feed mountain streams under the heat of the sun, and irrigate the valleys of the northern slope."

It must not be forgotten, moreover, that the Peruvian or Humboldt current, owing to the westward projection of Peru, comes near the coast. Captain Hoffman reports these water temperatures:

Coast water, Callao	18.2° C.
30 miles from the coast	20.6° C.
80 miles from the coast	23.8° C.
110 miles from the coast	26.2° C.
135 miles from the coast	27.° C.

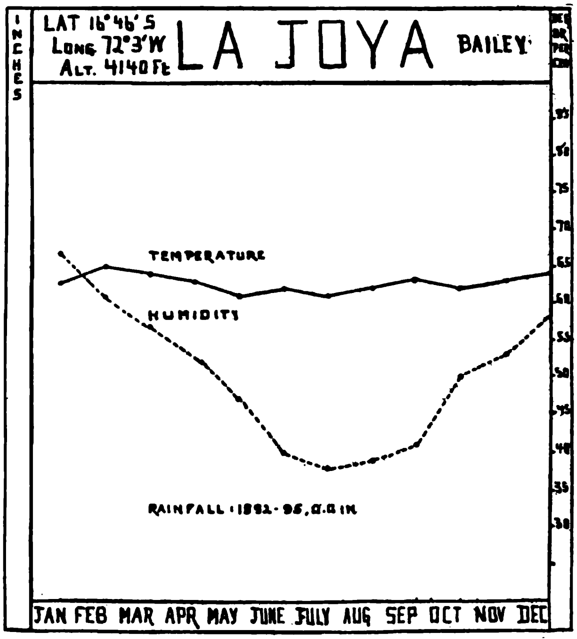
He reports that the cold water may be easily detected by its green color and thinks that to the material reduction of the air temperature due to its presence is due the fogs, *garuas,* of Peru which are thus the exact homologue of the *cacimbos* of Venezuela. Lest the question arise how cold water, even if it hugs the coast, can possibly cool the air, let me add that while the prevailing trades of course move from the land to the ocean, yet the sun heats the desert so effectually that about 11 A.M. a reëntrant wind is felt. This is



II. Lima is six miles from the coast. Notice that the rainfall is less than that of Mollendo.

so marked even at a short distance from the coast that navigators passing by keep outside that distance in order to get the benefit of the trades.

The drying southeast trades, the low pressure area of the desert, especially marked in their summer, and the Humboldt current account, then, for the fogs and the small precipitation of this region. At La Joya, in a period of three years, no precipitation of moisture greater than a trace was recorded. In Mollendo, one year gave a total annual rainfall of 1.07 in.; another, of .6 in. The total rainfall for three years and nine months was 2.65 in., or a mean annual rainfall of .07 in. In other words, both of these places belong to the famous *Zona Seca* of Peru.



III. La Joya is some distance from the coast. Notice the consequent absence o rain and very low humidity.

THE DESERT.

The *Zona Seca,* properly speaking, consists of the central and southern coast of Peru and the northern coast of Chile. Even here it rains occasionally, once in seven, or ten, or even fourteen years. Every officer of the boats that travel up and down the west coast of South America has his own particular story of when the desert bloomed and, where now is dry sand, once for a brief period, all sorts of plants, predominantly cucurbitous ones, attained amazing growth. Sometimes even in that brief span of existence they bloomed and bore seed. At some future time the seeds in their turn will make the bare places green again.

The northern part of the Peruvian coast, although a desert too, has more rainfall than the central and southern. In Lambayeque, the legends tell of a disastrous period of thirty days of incessant rainfall. This was followed, naturally enough, by pestilence and famine. Whereupon the priest, presumably to escape himself from a similar fate, threw the king, Tempellec, twelfth of his dynasty, into the sea. The Great Chimu obligingly gave them another king under whom they prospered.

Major Sears believes that Pizarro had the good fortune to begin his conquest in a wet year and says that had he attempted the conquest the year before, the desert would have conquered him!

The general impression that the passing traveller gets of the coast of Peru is that of a dismal, bare, gray sandhill region punctuated at wide intervals by wretched villages also gray and bare and desolate. At Payta, one may see the grave of an Englishman who lived there many years, longing always for a sight of the lush green meadows that he had left behind. After making a small fortune he returned to his home. But he was not content in England and finally came back to Payta and lived there until he died. The story is always received with an incredulous and non-understanding laugh, for the towns, many of them modern, and an expression merely of a foreign, money-seeking and temporary population, do get between one and the real beauty of the desert. Yet late in the afternoon it is exquisite, with mysterious colors reflected back from the setting sun. I can easily imagine that one who drank each day a deep draught of that wonderful beauty of color might be filled with longing for it in the midst of the commonplace comforts and the more conventional beauties of watered areas.

The southern part of the desert from north of La Joya down through the disputed provinces of Tacna and Arica has an additional charm in the strange *medanos,* crescent shaped dunes, with northwest wind-pointing horns. Their curious shape and onward movement is due to the prevalence of the southeast trade. To this influence, also, one must attribute the strange soft singing sound that comes from them at irregular intervals.

Professor Solon I. Bailey made a study of those near La Joya and found that they moved northward at the rate of from one to thirteen feet per month or from less than a half to less than six inches per day. Sometimes they were held back by obstacles in their path, bones of animals and the like—sometimes by the fog which at times actually wets the sands. At this rate of motion it must take them at least 2,000 years to reach the northern foothills where they disappear.

The region of the *medanos* has also the borax lakes, and near by are the nitrate deposits. It is interesting to remember that neither of these sources of wealth could still exist except in just such a dry and rainless region.

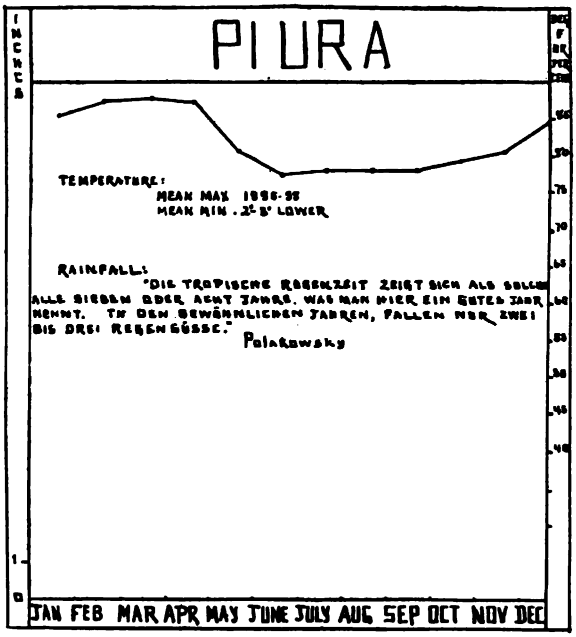
THE OASES.

From Tumbez southward, are forty-nine rivers, born either in the thawing Andean ice caps or else due to heavy rains in the Andes, flowing across the desert and losing their waters either in its sands or else in the Pacific Ocean. Very fortunately for Peru, it is the warm season that produces, or at least increases, the volume of the river, and the cold which gives them the fogs. Probably, therefore, nowhere in the world, is there a desert so dry combined with oases so numerous and so fertile.

Usually, because of their origin, these rivers are at their flood in February and March, and dry as early as June, but Francisco de Xeres, secretary to Pizarro, records the passing of the Piura, September 24, as follows: "And on the first day, his troops crossed the river on two rafts, the horses swimming." Further on he writes:

"On another day he travelled over a dry and sandy tract until he reached another well-peopled valley, through which a great and rapid river flowed. The river was much swollen, so the governor passed the night on the other side, and ordered a captain to swim across it with some others who knew how to swim."

The valley of the Piura is in the best watered part of the dry coast. How important is the coming of the water from the Andes in February or March may be judged by the ceremonies (whose roots doubtless are in the distant past) with which the grateful people welcome it. While it is still sixty miles away, some ride out to meet it. At thirty miles from the city it gets a greeting from Indians who send off rockets and play on fife and drum in its honor. Whole families ride out to see it when it is only a league away and children and dogs roll joyfully about in its waters. Sometimes there are five thousand people on the bridge of Piura when at last it flows underneath. All that night the band plays and the people dance. Six miles farther down, at Catacaos, sometimes 15,000 people have gathered about the banks in welcoming joy.



"DIE TROPISCHE REGENZEIT ZEIGT SICH ALS SOLCHE ALLE SIEBEN ODER ACHT JAHRE. WAS MAN HIER EIN GUTES JAHR NENNT. IN DEN GEWÖHNLICHEN JAHREN, FALLEN NUR ZWEI BIS DREI REGENGÜSSE."
POLAKOWSKY

IV. Piura is some distance from the coast. In spite of the absence of rain it is the centre of the cotton district because of irrigation from Andean streams.

To sum up the climate of the Peruvian coast: It is characterized by low humidity, especially in their summer months; low barometric pressure also, especially in the warmer season; negligible rainfall;

remarkably low even temperature, especially for this latitude. Its air is stimulating and all the climatic conditions make for health. What has been the effect of this climate on man in Peru? Obviously the most important control over the material things upon which civilization is built is its lack of rainfall.

INFLUENCE OF THE DESERT ON THE PEOPLE.

Desert soil is always not only rich but lasting. The salts of sodium, potassium, lime, magnesium, nitrogen, ordinarily leached from the soil by rain even more rapidly than they are taken from it by growing plants, remain intact in a desert soil. Then, too, the comparative absence of clay means a depth of ten feet or more of fertile soil accessible to air and water. One is too apt to think of sand in the terms of a sea beach or of rainy lands where everything is taken from the soil except the infertile silica.

The desert, therefore, blooms into wealth and beauty upon the addition of water. And just here the advantage of the Andean climate is added to the natural treasures of Peru in the form of the above mentioned forty-nine rivers. The world over, this combination of rich desert soils with water by which they might be irrigated has early produced civilization.

Egypt, Arabia, Palestine, Syria, Persia, the Sindh, Punjab, Rajaputana and northwest India, the valley of the Ganges, the Khanates of southern Turkestan, Carthage, Valencia, Granada, Malaga, the Inca civilization of Peru and the Aztec civilizations of Mexico are familiar illustrations of this law.

The story of the development of civilization in the coast lands of Peru, although less well known, indeed only recently known at all, is really an epitome of the histories of these other civilizations.

The aborigines, diminutive fishermen called Changas, were early driven out from the fertile river valleys, as they deserved to be, since they knew not how to develop them. There are still remnants of these people in Tarapacá, at Eten, Morrope, Catacaos, Sechura, Colan.

The subsequent civilizations that developed in the river valley had their highest expression in the north in the neighborhood of Trujillo and in the south in the valleys of Pisco and Ica.

The various civilizations of the coast were more or less contemporaneous but independent one of the other. For was not the desert between? A later civilization, the Chimu, seemed, however, rather to dominate the coast and it was these people that the Incas of the Sierra practically conquered a century or so before the coming of the Spaniards. They conquered them not because they were abler or better in any way but because, Max Uhle says, "they had the advantage of descending from the mountains by following a constant supply of water. The rivers diminish greatly in volume as they reach the coast and by seizing (often after long struggles) the outlets, the Incas had these valley tribes at their mercy."

Cieza de Leon gives this picture of one of the coast people: "The valley of Tumbez was formerly thickly peopled and well cultivated, full of fresh water courses drawn from the river to irrigate the land, and yielded maize and other things necessary for the support of man, besides plenty of delicious fruit. The ancient chiefs of the valley, before they were subjugated by the Incas, were dreaded and obeyed by their subjects in a greater degree than any other chiefs of whom I have yet written, and were served with much ceremony. . . . These Indians were addicted to their religion. . . . They till the ground in concert, with beautiful regularity, and raise maize and many kinds of well tested roots. The maize yields a harvest twice in the year, and peas and beans also come up abundantly when they are sown. Their clothes are made of cotton, which they grow in the valley, according to the quantity they require. These natives of Tumbez also have a great fishery, from which they derive no small profit, for with it, and their trade to the mountains, they have always been rich."

Without doubt the coöperation demanded from the coast people by reason of their rainless seasons for the erection of reservoirs and in the construction of irrigation works was the great civilizing agent. But good is ever the enemy of the best. This accomplished, the very ease with which the soil was tilled, the abundance of the crops, the perfection of the climate, made them quite content to enjoy life without further exploitation of its possibilities.

And they did enjoy it. The explorations of Reuss and Stübel at Ancon have made known to us something of the luxury of their garments and their jewelry. Even their weapons were richly ornamented. The decorations in the remains of their buildings, built of adobe (because of the rainless climate), show their love and mastery of color. Their pottery (also a natural response to desert conditions) is most interesting because of its decoration. On one there is represented a veritable dance of death with a skeleton playing the fiddle. A Chimu mummy is represented elsewhere, as if in the act of drinking, with a monkey whispering in his ear.

Yet they were religious, and surely they believed in immortality, else why the innumerable burial mounds, whose contents have told us the most that we know of their lives and customs.

They were wise and prudent, too. The climate compelled it. Every bit of the irrigated land was utilized for cultivation. Buildings of all kinds were erected just beyond the periphery of the oasis. The desert had to serve as a burial place. Sometimes, indeed, their burial mounds were very far away. Cieza tells of the Isla del Muerto near the island of Puna. "This island has neither inhabitants, wood nor water; but the ancient people of Puna had their cemeteries on it."

At least one of their ancient aqueducts still serves as an irrigating canal, that of Chimboto. The valley of Nasco owes to them its present fine system of irrigation. All that nature gave Nasco was a small water course, sometimes dry for six months at a time. They cut deep trenches up the valley to the mountains. Here the trenches are four feet high and lined with stones. Further down the trench ramifies in many directions. The larger branches are built several feet below the ground, to avoid useless evaporation. But every two hundred yards there is a manhole, thus making the stream almost as easy to control as if it were on the surface.

Yet the truest understanding perhaps that one has of those fascinating people, is that which pictures them to us enjoying life to the full; dancing, singing, drinking—"And certainly it is marvelous," writes Cieza, "the quantity of chicha that these Indians drink. Indeed the glass is scarcely ever out of their hands."

The climate made them.

The climate conquered them.

The people of Lima are Spanish, of course. Yet I fancy that they, more than the people of any other town of the coast, are inheritors of the spirit of the ancient coast peoples.

They are brilliant, versatile, emotional. When San Martin came from the south to free Peru from the yoke of Spain, half the boys of Lima fled from the school room to his camp.

Their city is gay and beautiful. They are constantly improving it. They love it. No true Limeño ever wants to live elsewhere, and when needs must, then he returns there as speedily as possible. Even the foreigner speaks of it as the cleanest town in Peru. So it is—in the center, but go to its corners, the zone just beyond the Rimac, and there the vultures tell the truth about the real cleanliness of Lima.

In the days before the Chilian war, when life was easier than it has been since, many gay "flower" parties were organized for the short time when the *lomas* were abloom. The people went out to the country, lived in tents, rode, bathed in the sea, sang, ate and danced, until the brief radiance of the fog or shower-fed vegetation had vanished.

GUANO. NITRATES.

These products are a direct consequence of the rainless climate. Both have brought great wealth to Peru, and then war and disaster.

Guano was known and used by the coast people and by the Incas long before the coming of the Spaniards—of it Garcilloso de la Vega writes as follows:

"They use no other manure than that of sea birds, which abound in all the coasts of Peru, and go in such great flocks that it would be incredible to one who had not seen them. They breed in certain uninhabited islands which are on the coast, and the manure which they deposit is in such quantities that it would seem almost incredible. In the time of the kings, who were Incas, such care was taken to guard these birds in the breeding season that it was not lawful for any one to land on these isles on pain of death, that the birds might not be frightened, nor driven from their nests. Each island was, by the Incas, set apart for the use of a particular province and the guano was fairly divided, each village receiving a due proportion."

Cieza speaks of it as follows:

"Out of the sea in the neighborhood of these valleys rise some islands much frequented by seals. The natives go to them in balsas and bring a great quantity of the dung of birds from the rocks to apply to their crops of maize, and they find it so efficacious that the llano, which formerly was sterile, becomes very rich and fruitful. If they cease to use this manure they reap little maize. Indeed the people could not be supported if the birds, lodging on the rocks round these islands, did not leave that which is afterwards collected, and considered so valuable as to become an article of trade between the natives."

Although, as has been seen by the foregoing extracts, the value of guano was well known before the time of the Spanish conquest, it was not until 1847 that it became an important export from Peru. From that time until 1883, when its price suddenly fell, it was the most important crop of Peru, making that country, temporarily, one of the richest in the world, judging by the per capita wealth of its population.

It has been estimated that from the three Cincha islands alone over twelve million tons of the fertilizer have been taken away. Hundreds of ships waited in the harbor of Pisco for their cargo of manure. Europe, with its exhausted soils, needed it and was willing to pay $65 to $75 per ton for it. From its sale the state reaped an annual harvest of nearly fifteen million dollars a year.

To the everlasting credit of someone or something, whether climate or people, or, as is more likely, President Castilla, the first use made of this enormous income was to set aside a portion of it yearly to pay the interest on the national debt. This debt was a series of loans contracted in England from 1822–1825, in consequence of the war for independence. No attempt was made to pay the interest until 1849, but from that time until 1876 it was regularly paid.

But, of course, mere payment of interest did not make much impression on Peru's immense income from guano. Therefore large public works were undertaken. In deciding upon these, absolutely no attention was paid either to climate or topographical controls. Instead of irrigating the west coast lands, they built mountain railroads at such enormous cost, up such steep gradients, that even to-day the llama competes with them successfully.

In consequence of the government monopoly of guano, the national revenue was quite sufficient without any taxation. Add to this the fact that the navy and military were well and promptly paid and numerous; that there was plenty of well-paid work for all who needed it; and in addition, one of the world's most agreeable climates, it is easy to picture, and, perhaps, envy a little in passing, the everyday life of the people in the larger coast towns, more particularly in Lima.

Under Balta the pace of national expenditures waxed faster and more furious, for to the generous ardor and natural impulsiveness of the Peruvian was added the spur of the Californian temperament. Henry Meiggs financed more and yet more railroads until, in his time, $29,000,000 had been expended and when he died over $124,000,000 worth of contracts were in his hands. Nor was this all. Port works and water works were undertaken. Roads through the Montaña were begun. Iquitos was established, and steamers were placed upon some of the Amazonian tributaries.

In the meantime the guano, stored by the centuries, was being torn from the rocks in days and hours, even minutes of time. The inevitable happened. Peru was bankrupt. In 1876 she ceased to pay the interest on her national debt.

Again the climate came to the rescue. Peru had nearly exhausted the capital given her on her rainless islands. She discovered about this time the value of her rainless southern pampas. A government monopoly was created of all her nitrate fields.

In 1877, the Peruvian government received over four million dollars for her guano export and over four and a quarter millions for her nitrate, with the absolute certainty that this was only the small beginning of the nitrate trade.

But just south of Peru lies a country whose motto, still to be read on many of her coins, is "*Por la razono por la fuerza,*" which can perhaps best be translated by "Might is right." They had the might, largely, doubtless, because of their colder climate with its spur of changing seasons (comparatively speaking). They, too, wanted the nitrate fields, and they took them by force of arms.

There are people who think that the ensuing desolating war was a blessing in disguise. One must balance $25,000,000 per annum against the vitalizing effects of poverty and the necessity for taking off one's coat and going to work.

Before leaving the subject of guano it is interesting to note the rejuvenation of the industry. In 1905 the total export was not quite a million and a half dollars, in 1906 one million eight hundred thousand. The birds have been returning to their former haunts and the government has shown an intelligent desire not only to protect them and their nestlings, but in other ways to farm the product intelligently.

AGRICULTURE.

But the permanent prosperity of any nation is not in its mines, however valuable—all mineral wealth has a way of taking to itself wings and flying away.

Never since the days of the enlightened Inca and Chimu has Peru taken so intelligent an interest in agriculture as at the present time. In 1906 was graduated the first class from the National School of Agriculture. The government is making liberal grants of water and land. Many irrigation companies have been formed and valleys of the Chira, Piura, Lambayeque and Chicama again bear the look of smiling prosperity which so impressed the Spanish chroniclers.

To-day, Peru's most valuable export is sugar. In 1906 the value of the export was about seven million dollars. Cotton, of which two and a half million dollars was exported in the same year, is the next most valuable of the coast products.

The story of each of these staples is very interesting for each illustrates the peculiar advantages of the Peruvian coast climate. Think of a climate and soil which will give the first yield of upland cotton within six months of planting and then yield two crops a year for three or four years without replanting. This surely is a generous return to foreign seed. Even more extraordinary are the facts with reference to the native cotton. No ploughing or cultivating of the ground is necessary and but one irrigation a year. The seed is dropped into holes ten feet or so apart. Between the rows thus planted, melons and pumpkins (true children of the desert) and corn are planted, that the farmer may have something on which to live while waiting for his crop. Not that he waits long. At the end of eight months, many bolls containing the peculiar rough and pinkish fiber are ripe. From that time on, he can count on two crops each year, from June to October for the one harvest, and from December to March for the other. The best crops, however, are those of the second, third, and fourth years. For this reason, it is customary to replant every four years. The plant will continue to bear, however, for twenty years, and there are plants in existence said to be forty years old. Such plants as these are fifteen to twenty feet high and as leafy as young trees, but, of course, the bearing crop is pruned back to six or seven feet.

The demand for Peruvian cotton has been greater than the supply ever since its use as a wool adulterant became known in the early nineties.

There are only two things to disturb the calm of the cotton grower: One is the fact that in rainy years his crop may be destroyed by an insect, and the other is the ubiquitous labor problem. However, as the rains are not likely to come oftener than once or twice in a dozen years, he is a much happier man than his homologue in other climates.

The sugar planter, too, can count with certainty on the climate. No sudden changes of temperature, no destructive storms, no fear of drought ever disturb his serenity. The untoward simply cannot happen in Peruvian coast agriculture.

As a proof of the extraordinary fertility of the soil these figures are of interest:

Country.	Quintals of Cane per Acre.	Quintals of Sugar per Acre.
Peru	700–900	56–80
Java	312	31.2
Hawaii	290	29
Egypt	192	19.2
Louisiana	175	10.4

Although sugar and cotton are the two largest crops from the Peruvian coast, other products are successfully raised. Delicious tropical fruits, first among which rank the *chiromoya* and the *palta,* synonyms for the custard apple and alligator (avocado) pear of the West Indies, the vine and olives—all are raised for home consumption. Rice and tobacco are successfully grown. Coffee, usually impossible to grow on tropical lowlands, here pays tribute to the unusual coolness of climate. And Panama hats, although, on account of the dryness of the air, woven either on damp moonlight nights or under water, are here extensively manufactured.

It is as Cieza wrote centuries ago:

"All is so good that no fault can be found, but rather thanks should be offered to the great God our Lord, who made all these things. Certainly if all commotions and wars were at end this would be one of the best countries in the world to pass a life in, for we see in it neither hunger, nor pestilence, nor rain, nor thunder and lightning, but the heavens are always serene and very beautiful. I could have mentioned some other particulars, but as it seems to me that I have said enough, I shall pass on."

(*Concluded in October Issue*)

THE COMMERCIAL WOODS OF THE UNITED STATES AND THEIR USES.

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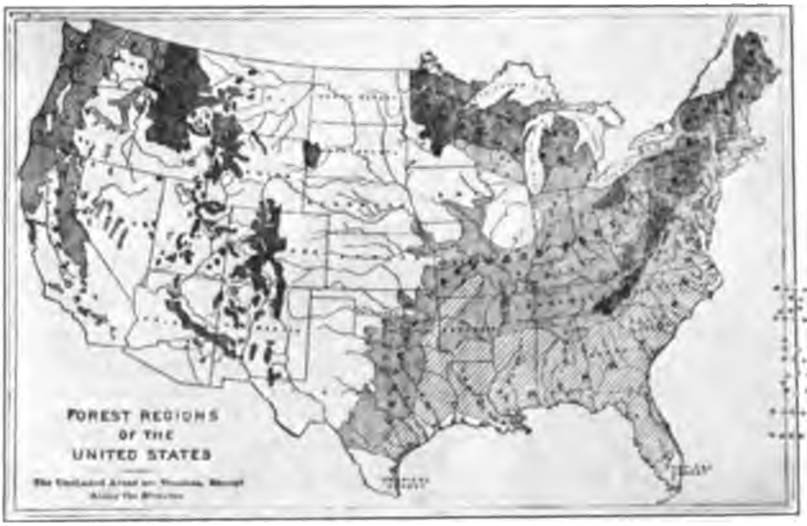
Nature bestowed a rich heritage on the North American continent in the abundance, variety and distribution of useful woods. The topographic configuration is such that the United States and Canada were both amply supplied with representative species of hard and soft woods. The United States has a wooded area of more than 600,000,000 acres but probably no more than 300,000,000 acres of this should be classified as merchantable timber. Canada has about 800,000,000 acres of woodland, about 300,000,000 acres of which is classed as merchantable timber. The national forest reserves of the United States exceed 165,000,000 acres and the activity of the federal government in this capacity may be judged from the fact that the total reserves contained, in 1905, 97,711,000 acres. The Canadian government has been very active in recent years in the extension of her forest reserves, and has at this time 100,000,000 acres of merchantable timber under government control and protection. This activity on the part of both the United States and Canadian governments in behalf of scientific forestry and economic cutting was impelled by the regional exhaustion of timber resources, enormous losses from wasteful cutting, forest fires and deforestation, the phenomenal rise in price, and the inevitable lumber shortage of the future without a change of methods and policies. Since 1870 the loss from forest fires has averaged $50,000,000 and fifty lives annually, and the area burned over represented about one half of the total forest area. The average price of standing timber has increased more than 50 per cent. during the past decade.

It is impossible to estimate accurately the amount of standing timber, but 2,500 billion board feet is probably a conservative estimate for the merchantable timber of the continental United States. It is correspondingly conservative to place the total annual lumber consumption at 50 billion board feet. The commercial increase



FOREST REGIONS
OF THE
UNITED STATES

by natural growth averages about 2 per cent. per year on growing timber, on which basis it is estimated that the annual growth averages 12 cubic feet per acre, or about 7 billion cubic feet in our total forests. The annual consumption and destruction, however, exceeds 20 billion cubic feet, so that we are drawing heavily on the forest principal and have already reduced that principal by one half. It is, therefore, obvious in the light of these conditions that the timber supplies must not only be conserved but increased if we are to provide for the increased demands of the next generation.

GEOGRAPHIC TIMBER BELTS.

Since it is impossible to consider with appreciation or intelligence the economic and commercial uses of our domestic woods without some familiarity with their geographic distribution, we will take the space to outline briefly the geographic timber belts and the important merchantable species occurring in each belt. These will be enumerated with approximate correctness in the order of productive importance, as based on the lumber reports for 1909.

NEW ENGLAND BELT.

Maine.—Spruce, white pine, hemlock, birch and oak.

New Hampshire.—Spruce, hemlock, oak and chestnut.

Vermont.—Spruce, hemlock, birch, white pine, beech, basswood and oak.

Massachusetts.—White pine, spruce, hemlock, oak and chestnut.

Rhode Island.—This state has practically no merchantable timber.

The percentage of wooded area in the New England belt is large, but the merchantable timber has been largely exhausted in all of the New England states except Maine. More than 75 per cent. of the total area of Maine is wooded, more than 50 per cent. of New Hampshire, and 43 per cent. of Vermont; but this represents chiefly cut-over land grown up in undergrowth and under present conditions of management gives very little promise for the future.

NORTHERN APPALACHIAN BELT.

New York.—Spruce, hemlock, white pine, beech, oak, birch and basswood.

Pennsylvania.—Hemlock, oak, white pine, chestnut, beech and birch.

Maryland.—White pine, oak, hemlock and chestnut.

West Virginia,—Hemlock, spruce, oak, poplar, chestnut, basswood and beech.

Kentucky.—Oak, poplar, yellow pine, gum and hickory.

Virginia.—Yellow pine, oak, poplar, hemlock, cypress, chestnut, white pine and gum.

The forest species and resources of the northern and southern Appalachian states are sufficiently different to justify differentiation in an economic discussion. The states enumerated above, together with Ohio and Indiana which are grouped with the Lake States, constitute the heart of the great hardwood[1] belt of this continent, which is the largest, most productive and most varied hardwood belt in the world.

If we consider the combined lumber production of all the states in the belt the merchantable woods ranked in 1909 in the following order: Hemlock, oak, yellow pine, spruce, poplar, white pine, chestnut, hickory, beech, cypress, basswood, birch and gum. The high rank held by the soft woods in this belt is attributable to the previous exhaustion of the most important and best grade hard woods throughout all the states of the belt. Hemlock, which is now being vigorously exploited in the lumber business, was considered practically valueless for lumber a few decades ago, and was utilized chiefly for the bark which was eagerly sought by the tanneries of the east.

SOUTHERN APPALACHIAN BELT.

Tennessee.—Oak, yellow poplar, gum, cypress, hickory, ash, walnut and elm.

North Carolina.—North Carolina pine, oak, long leaf pine, poplar, chestnut, hemlock and ash.

South Carolina.—North Carolina pine, long leaf pine, gum, poplar, oak, white pine, ash and hickory.

Georgia.—Yellow pine, cypress, oak, poplar, gum and ash.

Alabama.—Yellow pine, oak, poplar, gum, cypress and hickory.

Only the northern half of Georgia and Alabama can be properly

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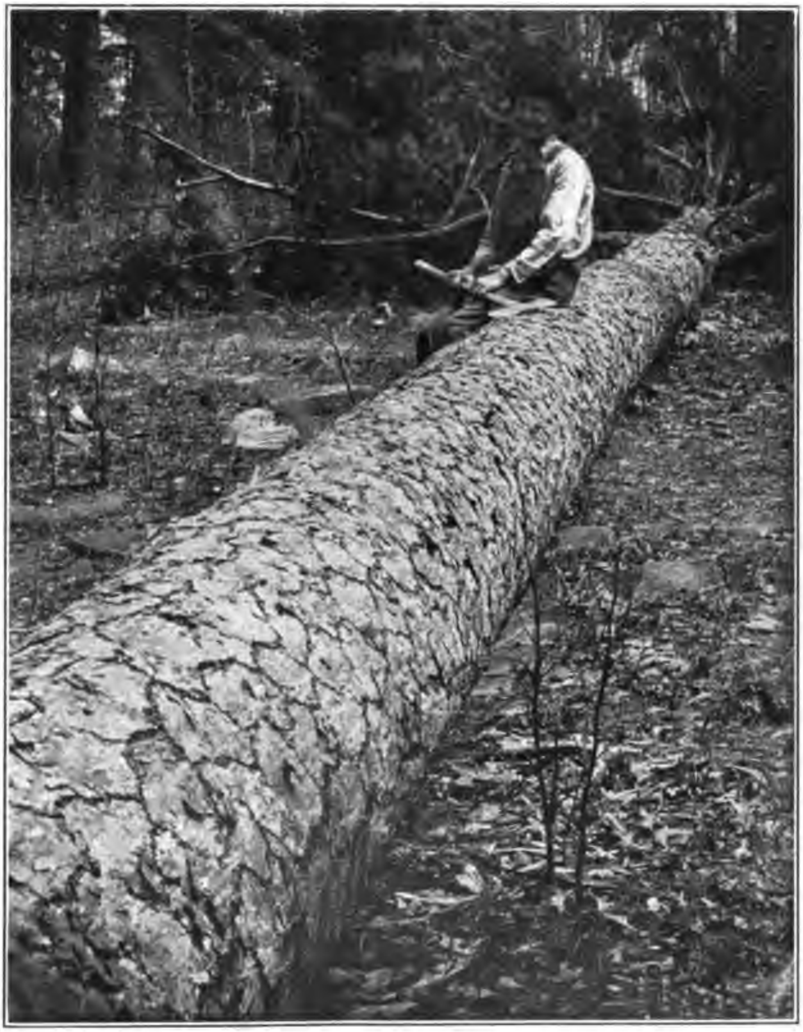
[1] All deciduous trees, or trees which drop their leaves annually, are classified as hardwoods; while the conifers, or needle-leaf evergreens, are included under soft woods. The classification is arbitrary and is not based on physical hardness, since Southern yellow pine, a soft wood, is very much harder than yellow poplar, which is a hardwood, according to this classification.



FALLEN SHORT LEAF PINE—ARKANSAS.

grouped in this belt since the southern half of these states is predominantly of the gulf types. Taking the belt as a whole the merchantable woods in the order of 1909 production are: short leaf pine, oak, long leaf pine, poplar, gum, cypress, white pine, chestnut, hickory, ash and walnut.

The hard woods represent the greatest variety of species throughout the mountainous part of this belt and improved forestry should make them the most important part of the future lumber supply. Leaving the mountains the yellow pines predominate on the uplands and the persisting hardwoods confine themselves chiefly to the valleys and lowlands.

GREAT LAKES BELT.

Ohio.—Oak, poplar, elm, ash and hickory.

Indiana.—Oak, elm, gum, poplar and hickory.

Michigan.—Hemlock, maple, white pine, beech, birch, elm, ash and oak.

Wisconsin.—White pine, hemlock, birch, maple, basswood, elm and oak.

Minnesota.—White pine, hemlock, basswood, birch and oak.

Considering the belt as a whole the following woods lead in the order of production: White pine, hemlock, maple, birch, oak, elm, basswood, beech and gum. It is obvious from the enumeration by states that Ohio and Indiana constitute a western expansion of the Appalachian hardwood belt and that soft woods are of predominant importance in the northern lake states. It should be noted that with the exhaustion of the magnificent white pine forests of that region has come a vigorous development of maple, birch and beech, and this is the only timber belt in which these hard woods figure conspicuously either in supply or manufacture.

It is estimated that the virgin forests of the lake states contained 350,000,000,000 feet of white pine and constituted the largest continuous white pine growth in the world. More than six sevenths of this supply has been cut and marketed, and with the development of the lake region the lumber industry has been pushed steadily westward, so that whereas Michigan was formerly the largest producer, Wisconsin and Minnesota now lead, each producing almost an equivalent amount of merchantable lumber. A review of the lumber output in this belt during the past five years shows a gradual decline, but for the same period the hardwood production shows a considerable increase.

GULF BELT.

Southern Alabama.—Yellow pine, oak, poplar and gum.

Southern Georgia.—Yellow pine, cypress, oak and gum.

Florida.—Yellow pine and cypress.

Louisiana.—Yellow pine, cypress, oak, gum, cotton wood, hickory, poplar and ash.

Mississippi.—Yellow pine, gum, oak, cotton wood, cypress, ash and poplar.

Texas.—Yellow pine, oak, gum and cotton wood.

Arkansas.—Yellow pine, oak, gum, cotton wood, cypress, ash and hickory.

The merchantable woods of this belt in the order of production are long leaf pine, short leaf pine, oak, cypress, gum, cotton wood, poplar, ash and hickory. This is the great yellow pine belt of the United States, the annual cut of which is much in excess of all other woods marketed from the region. The milling operations are conspicuously active in this belt because of the large areas of virgin forests and their accessibility to the great lumber-consuming centers east of the Mississippi River. The forests are of the swamp, valley and upland types. The representative swamp and valley woods are cypress, white cedar, live oak, water gum, water hickory, black gum and cotton wood. Leaving the swamp levels the short leaf pine becomes the predominant species, and at an elevation of 300 to 400 feet the long leaf pine begins to supplant the short leaf.

ROCKY MOUNTAIN BELT.

Montana.—Western yellow pine, larch, fir, western white pine and spruce.

Idaho.—Western yellow pine, western white pine, fir, cedar and hemlock.

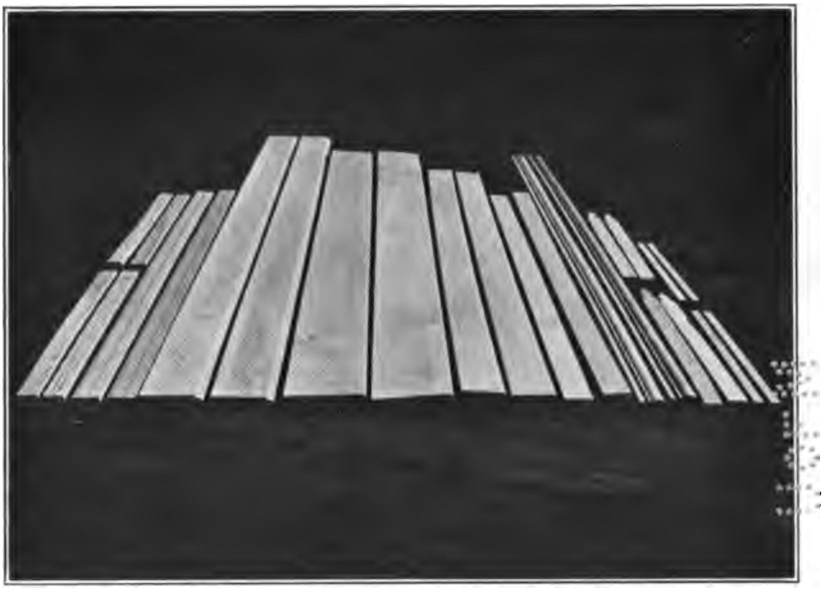
Wyoming.—Western white pine, and spruce.

Colorado.—Western white pine.

Arizona.—Western yellow pine.

New Mexico.—Western yellow pine.

The number of merchantable woods in this belt is less than in



LUMBER MANUFACTURED FROM THE 'FALLEN SHORT LEAF PINE.' Looking from left to right you see two rows of bed slats, two of ceiling, two of 8″ base, two of 10″ base, two of 6″ casing, two of 4″ flooring, two of crown moulding, and two each of flat and square pickets.

any other belt of the United States. Western yellow pine is first in the order of production, with western white pine second, larch third, and fir fourth. The climatic conditions throughout most of this large area are unfavorable for the development of woods of merchantable sizes and species. The few species occurring are quite local and the supply small, except in the states of Montana and Idaho.

PACIFIC COAST BELT.

California.—Red wood, western white pine, sugar pine, fir, western yellow pine and spruce.

Oregon.—Fir, western yellow pine, spruce, western white pine, larch and hemlock.

Washington.—Fir, cedar, western yellow pine, spruce, western white pine and larch.

Combining the output of the Pacific coast states the woods show the following rank in the order of production for 1909: fir, western yellow pine, red wood, western white pine, spruce, cedar, larch, hemlock and sugar pine. It is obvious from this enumeration that hardwoods are inconspicuous in this important lumber producing belt. Fir constitutes at this time about 60 per cent. of the total annual cut, and the fir production has more than doubled since 1902. The Pacific coast belt contains the largest virgin forest areas remaining in the United States, and the lumber industry in this region is being promoted rapidly at this time, the increase in total lumber output during 1909 being 44 per cent. above that of 1908. It is estimated that the three coastal states of this belt contain one third of the standing timber of the United States. About 71 per cent. of the state of Washington is wooded, 57 per cent. of Oregon, and 22 per cent. of California. The remoteness of this belt from the large consuming centers of the United States has naturally preserved its timber supply against the time of greater need when other important producing fields have been largely exhausted. The urgent demand for certain lumber products is drawing some of the Pacific coast product across the continent. Washington with her magnificent supply of cedar has almost monopolized the shingle industry and ships them not only to all parts of the United States but into practically every country of the earth. The growing scarcity of lumber in the east, the industrial development of the

Rocky Mountains, Great Basin and Pacific coast states, and the prospective opening of the Panama Canal in the near future will all operate towards greater activity in the development of the Pacific coast lumber resources.

ADAPTATION AND VALUE.

The uses of woods change with the industrial development of any country. A region rich in forest growth possesses the potentiality of becoming important in agriculture when the forests are removed. The clearing cannot be accomplished economically without good transportation facilities and accessible consuming centers. In the earliest stage of development neither of these can be expected, as a result of which the timber waste in the pioneer stage of all wooded countries has been general and heedless.

Each new industry promoted makes its substantial demands on the most accessible forest resources with the result that from the pioneer stage to that of diversified production and manufacture the wooded regions become more restricted to the lands less adapted to cultivation. The commercial uses of woods naturally become more selective and economic with the decrease and concentration of supply, with the extension and improvement of transportation facilities, and with the development and differentiation of manufacturing industries. The growth of domestic industries also enlarges the field of foreign trade, and makes possible a more rational selection of woods by importation.

The utility of our native woods is determined largely by the physical properties of the species, the natural conditions of growth, geographic distribution, markets, proportion of merchantable lumber of recognized grades and the presence or absence of economic substitutes. The uses fluctuate and readjust themselves in response to changes in the character of the supply and the peculiarity of the demand.

The commercial value of the wood is determined chiefly by its physical adaptability to specific uses which makes the *physical properties* of woods of first consideration in any discussion of adaptation and uses. The most important physical properties are hardness, elasticity, transverse and vertical strength, grain character, shrinkage and checking, durability, requisite sizes, color, odor, immunity to insect attack and susceptibility to fire. The relative value of these different properties depends directly on the requirements in the use to which it is intended. The natural conditions of forest growth in the individual species determines with fair accuracy the character of the physical properties attached to species and individuals. Every lumberman and every man who has frequented the forests has become cognizant of the fact that rapid growing trees of different species possess certain properties in contrast with the properties possessed by species of slow growth. To illustrate, trees of rapid growth are as a rule soft, brash, low in elasticity, regular in grain, comparatively free from abnormal developments, intolerant of shade, easily susceptible to the ravages of storms and more capable of resisting insect attack because of greater vitality. Trees of this type also contain a large proportion of sap wood and the development of the annual ring structure is not so well defined as in species of slow growth.

Classified Uses.

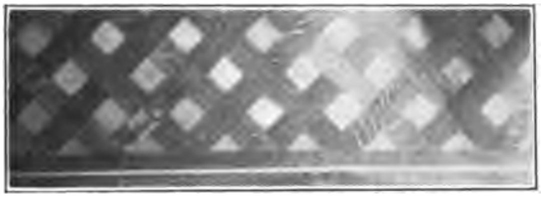
Heavy Construction.—Prior to the introduction of structural steel and reënforced concrete, this was the largest class of structural uses of woods and one of the most critical in selection. Though still important and still a heavy consumer greater economy is being practiced in it than in any other branch of construction, with the possible exception of roofing. The demands for large dimension lumber in the constructoin of bridges, viaducts, large buildings, cars, ships, machinery mounting and mining supports have been either eliminated or vastly reduced throughout this country. The demand for sills, beams, joists, etc., in the construction of dwelling houses, small factories and small business houses is large and the consumption is still heavy in car and ship-building, mining operations and temporary bridging.

The selection of woods for heavy construction must take into account the woods available and the fitness of each as determined by its properties. Requisite dimensions, weight and tension resistance, and durability are the most important considerations. All of the timber belts of the United States originally contained woods which fulfilled satisfactorily the essential requirements of heavy construction lumber. Thirty years ago white pine was the most popular and most used in the New England and Great Lake timber belts, while white oak and yellow poplar held the same place in the Appalachian belt and the states of the Ohio valley; but the exhaustion of the supply and the phenomenal rise in the price of these woods has demanded the substitution of more abundant species and cheaper grades.

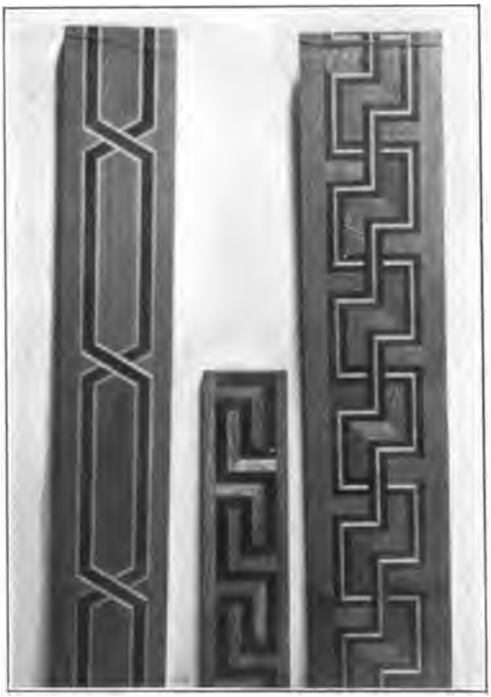
The present demand in New England is largely supplied by native and imported spruce, fir, hemlock and larch, and by the importation of yellow pine and cypress from the gulf states. The demand in the Appalachian belt is met by a large number of species, the most important of which are native yellow pine, imported yellow pine, inferior grades and species of oaks, hemlock and spruce. The Upper Mississippi valley and lake states import western yellow pine, southern yellow pine and cypress, and utilize their native red pine, hemlock, spruce and larch. Yellow pine is almost exclusively used in the great yellow pine belt extending from North Carolina to Texas. Western yellow pine is most extensively and universally used in the Rocky Mountain belt, but larch, fir and spruce constitute a conspicuous part of the supply in the northern states of this belt. Fir, western yellow pine, red wood, spruce and cedar are the leading heavy construction woods in the Pacific coast states. Of these, fir is most abundant, and therefore, most used, but red wood and cedar are most durable in contact with the ground or moisture, and so are preferred for underground and exposed construction.

By reason of the dimension requirement as well as the demand to withstand great weight and sudden shocks most kinds of *pole construction* belong logically under this division. Timbers for derricks, masts, electric light poles, telegraph poles, and piles have increased steadily in price because of the greater demand, and the exhaustion of supplies adapted to the purpose. To be adapted to this kind of construction the wood must be durable and elastic, of requisite length and diameter, and comparatively light. The native woods which fulfil these requirements most completely and therefore in most general use are spruce, larch, white cedar, (arbor vitae) cypress, white pine, yellow pine, red or "Norway" pine, fir, elm and chestnut.

The steam and electric railroads pay more than $75,000,000 annually for cross-ties. Oak constitutes more than 40 per cent. of



QUARTERED OAK, WALNUT AND CHERRY.



QUARTERED OAK, CHERRY AND MAPLE.

QUARTERED OAK AND CHERRY.

QUARTERED OAK, CHERRY AND HOLLY.

Courtesy Wood-Mosaic Co., Rochester, N. Y.

QUARTERED OAK, WALNUT AND CHERRY.

QUARTERED OAK AND WALNUT.

QUARTERED OAK, WALNUT AND MAPLE.

Courtesy Wood-Mosaic Co., Rochester, N. Y

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the total, followed by yellow pine, Douglas fir, cedar, cypress, larch, chestnut, redwood and hemlock.

Light Construction.—For convenience we will group under this class, light framing, doors, windows, siding, flooring, ceiling, sheathing, laths, shingles, moldings, wood paving and boxes.

A large number of woods are adaptable to the manufacture of *light framing.* Those in demand for heavy framing, previously discussed, supply the bulk of the light framing, but the intermediate or low grades of practically all other merchantable native woods are used in varying amounts. The southern yellow pines, spruce and hemlock, lead in the east, and fir, spruce and western yellow pine in the west.

Doors and *windows* have become largely factory products and are made in both plain and cabinet finish. For plain doors and windows soft woods are used almost exclusively, the best adapted for the purpose being white pine, sugar pine, Idaho pine, redwood, cypress, fir and spruce. The most popular hard woods for the cabinet finish are oak, cherry, sugar maple, birch, white and brown ash, red gum and yellow poplar. The veneered hard wood door is growing in favor and rapidly supplanting the solid type.

Siding (weather boarding) was formerly manufactured largely from white pine, yellow pine and yellow poplar, but the scarcity and high price of white pine and poplar have necessitated the use of less valuable woods. They were ideally adapted because easily worked, free from knots, retentive of paint, and durable. The most valuable siding lumbers on the market are white pine, clear yellow pine, cypress, redwood and cedar; but spruce, larch, firs and hemlock are also being used extensively.

White pine was formerly the most used *flooring* lumber; in the order of efficiency and price are clear southern pine, cypress, Douglas fir, redwood, western hemlock and larch. The demand for hard wood floors is increasing steadily, but comparatively few species are adapted to this purpose. White oak, red oak, sugar maple, beech and birch are the only hard woods practicable for the manufacture of flooring. Quarter sawed white oak commands the highest price and is the most durable. The exhaustion of the high grade white oak and sugar maple supplies has brought a vigorous introduction of beech and birch floors. The most easily worked woods are in general best adapted for *moldings,* making white pine and sugar pine particularly desirable of the soft woods: and poplar, cotton wood, basswood, and eucalyptus among the hard woods.

Ceiling is not extensively used except in piazzas, factories, storage rooms and plain wainscoting. Cypress, redwood and cedar excel for outside work and other soft woods in use for flooring are selected for inside ceiling, the selection being based on accessible supply, price and the taste of the purchaser.

The lower grades of the general construction softwoods are utilized for *sheathing*. *Laths* are manufactured from a variety of woods, being largely a by-product of the mills. Any of the American soft woods and the softer of the hard woods can be successfully used. The only essential qualities are that the laths receive nails without splitting and not stain through the adhering plastering.

Notwithstanding the numerous roofing substitutes for *shingles*, there is a steady and increasing demand for them in building construction. Though of small dimension, the best grades of lumber must be used for the production of high grade shingles. White pine and chestnut were formerly the leading shingle woods of the eastern states, but red cedar from the Pacific coast states supplies now from 85 to 90 per cent. of the total product. Cypress, redwood, yellow pine, white pine, chestnut, oak and spruce produce shingles of good quality, and supply the remaining 5 to 10 per cent.

Experiments in *wood paving* began in 1845. The first blocks used were round and were not treated with a preservative solution. These wore irregularly and in consequence were quite unsatisfactory. The blocks are now cut in rectangular shape, and laid with the grain vertical. The essential properties to adapt a wood to this purpose are, receptive of the preservative solution, durable, impervious to surface drainage, and resilient. Creosoted long-leaf pine is considered the most satisfactory paving wood east of the Rocky Mountains, but cypress, cedar, white pine, hemlock, oak and cottonwood are also used. Redwood and fir are most universally used in the Pacific coast states. A good grade of wood paving well laid is superior to macadam, brick or asphalt in durability and quality of service, and exceeds them in cost. In traction resistance it is said to excel all other road materials, but for heavy traffic the blocks should be not less than four inches in thickness.

The softer the wood the more serviceable it is for *box* manufacture, these being most retentive of nails and resilient to shocks. The demand for boxes has increased with such rapidity as to make it difficult to supply suitable woods. In no other branch of wood manufacture have greater economies been inaugurated. The economies have been in the direction of utilizing less material for a given package, and in the use of woods and grades which were not considered in the days of low price lumber. High grade lumber is required for the manufacture of veneer stock (shooks), and the western fruit growers still demand boxes made of high grade material. Fortunately the cheaper hardwoods, cottonwood, basswood and gum are best adapted for veneer boxes. Practically all merchantable woods are utilized to a greater or less extent in box manufacture, but yellow pine, white pine, sugar pine, fir, spruce, hemlock, larch, cottonwood, gum, basswood, sycamore, elm, ash and maple are the most important. Some extent of this commercial demand may be judged from the fact that 60,000,000 feet of lumber is consumed annually in box manufacture in the city of Chicago.

Cooperage.—Cooperage materials consist of hoops, staves and headings, and the most important products are flour barrels, oil barrels, barrels for alcoholic drinks, molasses barrels, pork barrels, sugar barrels, tobacco hogsheads, barrels for vegetable and fruit shipment, nail kegs, water tanks, silos, creamery tanks, churns, butter tubs, laundry tubs, pails, etc. For the manufacture of silos, tanks, tubs and pails, red cedar and cypress are the best adapted of eastern woods, and red cedar and redwood of the western woods. Flour and meal barrels are made chiefly of elm, beech and maple. Oil and whiskey barrels are made almost exclusively of white oak. Ash enters largely into the manufacture of pork barrels and butter tubs, and yellow poplar is in demand for ale and beer receptacles. Basswood, gum and sycamore are beginning to be used in the manufacture of staves and headings, and hickory and elm are extensively used in the manufacture of barrel and tank hoops.

Furniture Manufacture.—The utilization of woods in this line of manufacture has always been determined by the fitness of the wood for the purpose and the natural or acquired taste of the purchasers. The choice must be more or less cultivated with reference to the woods available. Fifty years ago wild cherry and black walnut were the most esteemed American furniture woods. With the exhaustion of these woods, oak grew in popular favor until now it ranks first in total consumption among the native furniture woods. With improvement in the art of wood working and manufacturing sugar maple began to be extensively used and is now only second to oak. The price of suitable grades of white oak and sugar maple has increased so rapidly during the past two decades that more abundant and cheaper woods have gained prominence in furniture manufacture, the most important of which are red oak, birch, ash, yellow poplar, basswood, butternut, elm, chestnut, white pine, redwood, larch and yellow pine. In furniture manufacture great changes have been wrought in recent years through the veneering art, and veneered furnitures will continue to become more general with the exhaustion of the superior grade hardwoods. In this the core or base is either a cheap softwood or low grade hardwood, and the veneers are cut from the woods most popular in the manufacture of solid furniture.

Vehicles and Agricultural Implements.—There has probably been less change as to the woods consumed in this line of manufacture than in any other in which wood is used extensively. Steel has been substituted for wood in many parts, but the small number of woods which became popular in the pioneer days of our vehicle and implement manufacture still predominate. The most essential properties required in woods designed for use in vehicles and agricultural implements are elasticity, durability, slight checking, hardness and toughness. The following woods possess these properties most completely and are used most extensively in this kind of wood adaptation: yellow heart pine, white pine, hickory, elm, white oak, white ash, sugar maple, cypress, redwood, yellow poplar, cotton wood and basswood. Hickory is most used for the manufacture of spokes; elm for hubs; white oak for frame parts and spokes; white ash for parts requiring strong resistence from sudden shocks; yellow pine, redwood and cypress for tongues and framing parts; and poplar, cotton wood and basswood for the manufacture of parts requiring special widths.

Paper.—Paper is manufactured from plant fiber, and the grades of largest consumption are manufactured from wood. Since the United States does not possess large areas of species adapted to this class of manufacture there is need of alarm and preparation for the future paper supply. White spruce is in strongest demand as a pulp wood and is being exhausted rapidly. Red spruce and western spruce are now beginning to be used extensively. The other native woods utilized in paper manufacture are yellow poplar, aspen, chestnut oak, chestnut and birch. Pine is extensively used in central Europe in the manufacture of paper, and the silver fir in northern Europe. It is probable that the paper manufacturers of this country will soon be forced to the use of those species utilizable but which have not been exploited. We are the largest world manufacturers of paper, the total product being valued at almost $200,000,000 annually; and are the most profligate consumers, as shown by the relatively small export of less than $10,000,000. Our import of pulp more than balances the total paper export, and there is in addition an annual import of pulp wood of about $5,000,000.

Tanning Materials.—The leather industry was formerly dependent on accessible supplies of bark sufficiently rich in tannic acid to be adapted to tanning. The utilization of wood extract constituted the first departures from the exclusive use of tan-barks. The barks of hemlocks and oaks supplied the tanneries of the United States very largely. These are still utilized, and the oaks, chestnut and sumac are also used for the manufacture of wood extract. The reduction of our wood supplies has naturally brought about greater economy in the consumption of woods for the manufacture of by-products. The result is that the United States is both importing larger quantities of vegetable extracts for tanning purposes, and is also rapidly extending the manufacture of leather by chemical tanning.

Distillation Products.—Both hard and soft woods are exploited for certain volatile products contained therein which are useful in the arts and trades. There are now more than 100 factories in the United States for the distillation of hard woods and these consume about 1,000,000 cords of wood annually, valued at $3 per cord. The most important distillation products from these factories are alcohol, acetic acid, creosote, vegetable oils and pyroligneous acid.

Of the soft woods, yellow pine produces the most important distillation products, the extraction of which has been an important industry in the South Atlantic states since the colonial period. Turpentine and its allied products became important in the colonial commerce and were characterized in the trade as "naval stores." The industry started in New England and soon shifted to North Carolina, from which point the center of production has steadily moved southward, Georgia being now first in turpentine and Florida first in tar production.

THE PEARY MEETING AT THE ACADEMY OF MUSIC.

The meeting held at the Academy of Music under the auspices of the society on Friday afternoon, April 8, when Commander Peary delivered his lecture on the conquest of the North Pole, and received the special gold medal awarded him, was perhaps the most successful gathering in point of attendance and public interest in the history of the society.

Assembled on the stage were Governor Edwin S. Stuart, Commander R. E. Peary, U.S.N., Capt. Robert A. Bartlett, Rear Admiral George W. Melville, U.S.N. (retired), Mr. Amos Bonsall, Mr. Alba B. Johnson, Hon. Charlemagne Tower and President Henry G. Bryant.

In opening the exercises Mr. Bryant said:

"We have met this afternoon to honor, in a fitting manner, one of our countrymen who has accomplished one of the great geographical achievements of the centuries, and we are to hear from his lips the story of his discovery of the North Pole.

"The South Pole remains to be conquered. When that goal is reached the subjection of the earth to man's energies will be complete. Many of us hope that with a British and an American expedition in the field this final consummation will not be long delayed; but, in the meantime, no future success in the Antarctic by explorers of any nation can dim the glory which has come to America in that one of her sons—Robert E. Peary—has been the first to reach a pole of the earth and that pole—on the northern apex of the globe—perhaps the more difficult and elusive of the two, entrenched as it is, amid miles of ever-moving sea ice.

"When the history of Commander Peary's campaigns in the north is considered, it is altogether fitting that our society should commemorate his final success in a special manner. I need not remind this audience that the first Peary expedition was sent to North Greenland in 1891 under the auspices of the Academy of Natural Sciences of this city, while the auxiliary expedition of 1894 was assisted by a substantial contribution from our own society.

"In Professor Heilprin, the founder of our society, Commander Peary found a sympathetic and resourceful friend ever ready to aid with wise council and enthusiastic support, his plans for polar research.

"In addition to these considerations relating to Philadelphia's association with Commander Peary's work, there is an historical background which identifies our city with similar scientific explorations from earlier times. In 1753, the first American Arctic expedition planned by Franklin and other enterprising Philadelphians, sailed from this city with the avowed purpose of discovering the Northwest Passage, while in more recent times Philadelphia furnished one of the most gifted and chivalric leaders of the Franklin search parties in the person of Dr. Elisha Kent Kane, whose surviving shipmate, Amos Bonsall, is with us to-day.

"As an organization reflecting the present-day geographical interests of a city with such traditions—as a society which numbers among its honorary resident members that clear-sighted veteran of the 'Jeanette' expedition, Admiral George W. Melville, and many others interested in Arctic research—I say with such antecedents it would be strange indeed if this society failed to signalize in some special manner so momentous an event in geographical annals as the discovery of the North Pole. The board of directors has, therefore, awarded to Commander Peary a special gold medal for his great achievement and a silver medal to his able assistant, Captain Bartlett.

"His excellency, the Governor of Pennsylvania, has honored us with his presence to-day and I will now ask Governor Stuart to present the medal to Commander Peary."

Governor Stuart in presenting the medal on behalf of the society remarked that it was appropriate that Philadelphia should fittingly honor so distinguished an explorer as Commander Peary, inasmuch as "this city was one of the first, through the Academy of Natural Sciences, to encourage and financially aid his early efforts, and this recognition is all the more appropriate in view of the fact that he was born in the Allegheny Mountains, in Cambria County, Pennsylvania, a region that produced a hardy race of pioneers who bore an honorable part in opening up the great West." In handing over this token Governor Stuart remarked: "You have received other medals and will probably receive still more tokens of appreciation of your work, but from no other source will you receive one which carries with it more confidence in you than goes with this medal which I now have the honor to hand you on behalf of the Geographical Society of Philadelphia."

Responding, Commander Peary said: "I feel it difficult to tell you how deeply I feel the friendship you give me and the confidence you place in me. This medal will be doubly appreciated by me because of the associations that are here, and because it comes from the hand of Governor Stuart."

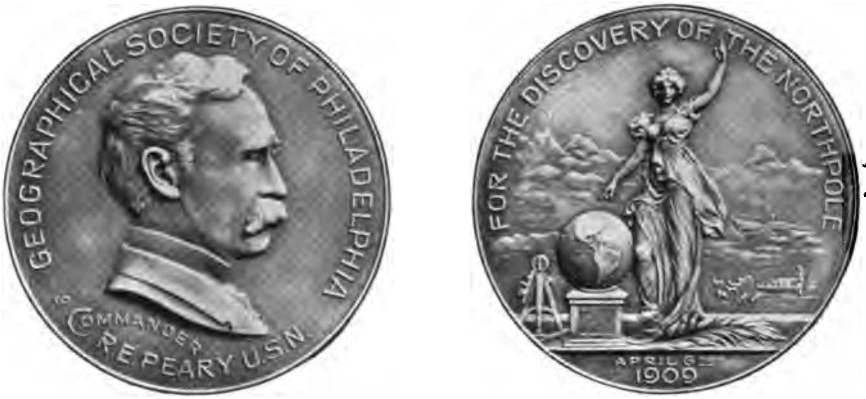
A silver replica of the special Peary medal, bearing a suitable inscription, was then presented by President Bryant to Capt. Robert A. Bartlett, commander of the S. S. *Roosevelt,* who was characterized as the "master mariner of the Bartlett clan and a man whom Peary had never failed to honor."

After thanking the society for the honor conferred on him, Captain Bartlett said: "I did no more than any man with red blood in his veins would do under the circumstances. With such a leader as Commander Peary why wonder that the North Pole was discovered. 'Go it boys, 90 degrees this time sure,' was our slogan," remarked Captain Bartlett in closing.

Commander Peary then delivered his lecture on the "Conquest of the North Pole"; briefly outlining the earlier attempts of navigators to reach this difficult goal, he carried his audience step by step from New York to his ship's winter quarters at Cape Sheridan and thence by masterly disposition of supporting sledge parties to the pole itself.

At the conclusion of the lecture, an informal reception was tendered to Commander Peary on the stage of the academy, during which a large part of the audience took occasion to pay their respects to the explorer.

The special gold medal awarded to Commander Peary by the society is the first distinction of the kind which it has ever bestowed. Its obverse contains a profile head of Peary encircled by the legend, "Geographical Society of Philadelphia to Commander R. E. Peary, U. S. N." The reverse of the medal shows a draped female figure representing America, standing on a low dais pointing with one hand to the northern apex of the globe and with her other upraised arm calling the attention of the world to the fact that one of her sons has attained the pole. Beside the globe is a conventional representation of a mariner's sextant. A loaded sledge with dogs and driver and a representation of the steamship *Roosevelt* form a fitting background and typify the means employed to reach the pole. Encircling the design are the words "For the discovery of the North Pole" and below the central figure appears the date of the discovery, April 6, 1909. The medal is the work of A. C. Frank, of this city, and was executed under the direction of a committee of the society.


GEOGRAPHICAL SOCIETY OF PHILADELPHIA
TO COMMANDER R.E. PEARY U.S.N.
FOR THE DISCOVERY OF THE NORTHPOLE
APRIL 6TH
1909

Medal Awarded to Commander Peary by the Society.

ANNUAL DINNER OF THE SOCIETY.

The annual dinner of the society was held on Friday evening, April 22, in the Clover Room of the Bellevue-Stratford. The guests of honor at this occasion were Sir Ernest and Lady Shackelton. The Antarctic explorer received at this time the Elisha Kent Kane gold medal which had been awarded him by the society in recognition of his services to geographical science in his recent expedition in search of the South Pole.

The dining room was very appropriately decorated with the enwrapped folds of English and American flags and the dinner was presided over by the president of the society, Henry G. Bryant. Mr. Bryant began by proposing a toast to the President of the United States and to King Edward, both being received with much enthusiasm. The Reverend J. Johnson Ross, pastor of the Bryn Mawr Presbyterian Church, was introduced as the first speaker.

"The object of the so-called Anglo-Saxon race," said Dr. Ross, "seems to be to act as missionaries, explorers and colonists. The English-speaking people are forming the foundation of a united family of humanity and I cannot think that it is merely accidental that this should be the case."

Mrs. Harriet C. Adams, well known for her travels and explorations in South America, next spoke and gave a most delightful and amusing account of some of her experiences in far lands.

The Elisha Kent Kane medal was presented by Rear Admiral Melville in a very simple speech and was received by the explorer in the same manner. After acknowledging his pleasure and gratitude in being awarded the medal, Sir Ernest spoke of the work of Admiral Melville in the north and of the high respect in which his work is held in England. Continuing, he said: "If there be any competition in getting to the South Pole, I hope it will be a Britisher who gets there first. Ours was the only expedition which returned from the Antarctic without the loss of a single life, and in honoring me to-night I feel you are honoring my various comrades who are now scattered throughout the world."

Other speakers of the evening were Thomas Hubbard, president of the Peary Arctic Club; Dr. Talcott Williams and Francis A. Lewis.

Others who were present at the dinner were: Miss E. P. Ashbridge, Miss L. H. Ashbridge, George Bailey, Jr., Miss Rachel P. Barker, T. Brown Belfield, Mrs. T. Brown Belfield, Robert B. Beath, Mrs. Robert B. Beath, Miss Emily Bell, Miss Laura Bell, G. A Bisler, Mrs. G. A. Bisler, Miss M. V. Bisler, Miss Mary Blakiston, George L. Bodine, Miss Helen Bodine, Miss Boltz, E. T. Bradway, Mrs. E. T. Bradway, J. H. Brazier, Mrs. J. H. Brazier, Mrs. Robert P. Brown, Peter Bender, J. E. B. Buckenham, Dr. Chas. W. Burr, Henry S. Cattell, Mrs. Henry S. Cattell, Miss Isabel Chambers, S. Hudson Chapman, Clarkson Clothier, Mrs. Clarkson Clothier, Robert Comly, Miss Marion S. Comly, Charles A. Converse, Miss Alice P. Converse, Joseph H. Converse, Miss Mary E. Converse, Morton Craven, Prof. Wm. M. Davis, Edward G. Dixon, F. Norman Dixon, J. Benjamin Eserwein, William J. Faux, Miss Faux, Wager Fisher, William R. Fisher, J. R. Foulke, L. Webster Fox, Mrs. L. Webster Fox, M. H. Fussell, Mrs. M. H. Fussell, G. H. Grosvenor, Mrs. G. H. Grosvenor, William A. Haines, Miss Haines, William S. Hallowell, Mrs. Wm. S. Hallowell, Thomas R. Harper, Prof. H. V. Hilprecht, Mrs. H. V. Hilprecht, Benjamin R. Hoffman, Miss May S. Holmes, Harry S. Hopper, Mrs. Harry S. Hopper, Gen. Thos. H. Hubbard, Alba B. Johnson, Prof. E. R. Johnson, J. J. Jones, Dr. Ernest Kelsey, The Rev. J. H. Lamb, Mrs. J. H. Lamb, Miss H. P. Lawrence, Henry Lawrence, Dr. Theo. Le Boutillier, Prof. William Libbey, Miss Libbey, Craige Lippincott, Mrs. Craige Lippincott, Miss Constance Lippincott, J. B. Lippincott, Mrs. J. B. Lippincott, William S. Lloyd, Mrs. William S. Lloyd, Dr. H. C. McCarthy, George W. Magee, Mrs. George W. Magee, Miss Josephine Mays, David Milne, Mrs. David Milne, E. P. Morris, J. P. Mumford, Mrs. J. P. Mumford, Miss E. C. Morris, Dr. C. F. Nassau, Mrs. C. F. Nassau, Charles Pancoast, Mrs. Charles Pancoast, Harold Peirce, Mrs. Harold Peirce, Wilfred Powell, Mrs. Wilfred Powell, Miss Rhodes, William H. Rau, Mrs. William H. Rau, William Rhodes Mrs. William Rhodes, Mrs. Charles Roberts, Robert F. Roberts, A. P. Robinson, Mrs. A. P. Robinson, Dr. W. J. Roe, J. G. Rodgers, The Rev. S. A. J. Rose, Mrs. S. A. J. Rose, John G. Rothermel, Mrs. P. F. Rothermel, J. N. Rawlings, John

Sailer, Dr. Paul J. Sartain, Mrs. Murray Shipley, C. J. Shoemaker, Mrs. C. J. Shoemaker, Dr. Harvey Shoemaker, Mrs. Wm. Simpson, Jr., Dr. Henry Skinner, Mrs. Henry Skinner, Frank W. Stokes, J. F. Thomas, Mrs. J. F. Thomas, The Rev. Wm. R. Turner, George Vaux, Jr., Mrs. George Vaux, Jr., William Vollmer, Mrs. William Vollmer, S. Harry Wade, Alexander Wilson, Jr., Mrs. Alex. Wilson, Jr., John Woodall.

GEOGRAPHICAL NOTES AND NEWS

The *Scottish Geographical Magazine* (April, 1910) contains an address on "The Geographical Relation of the Market to the Seats of Industry," delivered by Mr. George G. Chisholm before the Scottish Society of Economists. In his discussion of the question, the author seems to imply that the matter of the local market is one of the chief, if not the chief, factor in the general localization of manufacturing industries. Just what is meant by this "local market" is not stated clearly, but the use of the term suggests that the market of a city or town is indicated. Various examples are cited, as, for instance, a comparison of Calgary and Edmonton, in Canada, the latter of which, in a timber country, is less important in the manufacture of furniture than is Calgary, with its larger population and consequent greater market, in a timberless region. It is diffiult, however, to reconcile with this analysis the very rapid rise of Cedar Rapids, Mich., as a center of furniture manufacture, displacing the older and larger localities of Boston and Philadelphia.

Again, he points to the manufacture of sugar beet machinery in Saxony, where unquestionably there is a local market of much importance, but the paramount importance of the market will not explain the localization of the manufactures of cane-crushing machinery in Ohio, with no cane mills nearer than Louisiana.

As a matter of fact the local market—if "local" is interpreted even generously as regards the area included—will not by itself account for the centralization of most of the important manufacturing industries of the United States, as the leadership of New England in textiles, of upper New England and New York in paper pulp from wood, of Pittsburg and vicinity in iron and steel, of the southern states in naval stores, of Pennsylvania and New Jersey in the silk industry, and so on practically indefinitely. The question of raw materials, fuel and power, labor and transportation facilities are of equal importance, if not greater than, the question of local market in the matter of localizing major industries. Secondary, or dependent industries, like the relation of lasts to the shoe business, or of printing cloths to the cotton textile industry, may be controlled chiefly by the local demand for that special service. Yet spindles for cotton mills in New England are manufactured in Tennessee, and most of the leather used in the New England shoe factories comes from Texas or Argentina, may be tanned in non-shoe centers of Pennsylvania or New Jersey and be made into shoes in Brockton, Lynn or Haverhill, none of which possesses an important tannery.

In an address before the Scottish Geographical Society in March, Dr. W. S. Bruce outlined the plans for the Scottish Antarctic expedition which is expected to leave in 1911. The plans involve a bathymetric survey of the South Atlantic, a further exploration of the supposed "Rise" connecting the Sandwich group and Bouret Island, in these respects supplementing the work begun by the *Scotia* in 1902–1904. The ship will winter at Melbourne, and from there will proceed in the spring of 1912 to M'Murdo Sound, to send out a second party across the Antarctic continent to meet a first party which it is hoped will be able to start from Coats Land. The scope of work embraces oceanographic, meteorological, magnetic and biological investigations during a period of two to four years.

It is reported that a German expedition under the leadership of Lieutenant Filchner, is to seek the Antarctic in 1911, with the especial purpose of determining the shape of the Antarctic continent.

It is also rumored that a Zeppelin airship will be used during the coming summer in an exploration of some of the unknown areas of Spitzbergen and Franz Josef Land. Cross Bay is said to have been chosen as the base of operations, with two vessels detailed for additional work.

Sir Ernest H. Shackelton has been awarded the Cullum Geographical Medal, by the American Geographical Society, in recognition of his work in the Antarctic during the years 1907–1909.

Interest in the question of the ascent of Mt. McKinley is enlivened by the almost simultaneous reports that the expedition under Professor Herschel C. Parker has sailed from Seattle for Alaska, and that the American flag has been planted at the top of Mt. McKinley by a party of men from Alaska. It is reported that these men found no trace of any previous ascent.

The sand dunes of the Libyan Desert are described in an interesting illustrated article by H. J. Llewellyn Beadnell in the April number of the *Geographical Journal.* The author points out the economic significance of dunes in that the welfare of thousands in the oases of deserts are intimately connected with their rate of movement and mode of accumulation, in some cases extensive towns being blotted out of existence by the advancing sand, in others the wind-borne accumulations forming broad terraces of cultivable loam, constantly fertilized by the accumulating dust. The subject of sand dunes is also of first importance in the engineering projects connected with irrigation and railroad building.

The most important dune areas of the Libyan Desert are west of the Nile, where they occur as narrow, elongated belts or as irregular accumulations of various dimensions, made up of material derived from the sandstone area to the north and deposited by the prevailing northerly winds. The dominant form of the dunes is crescentic, or horseshoe shape, ranging in size from only a few feet in width to enormous masses, 100 or 125 feet high and 600 to 1,000 feet in breadth. Mr. Beadnell's observations show that the dunes progress steadily southward at an average rate of 33 feet to 68 feet per year, the larger dunes moving less rapidly than the smaller ones.

A recent issue of *La Géographie* contains an interesting paper by M. Étienne Clouzot on the origin of towns. He divides towns into two classes: natural towns, which have developed slowly, beginning as isolated dwellings and passing through the stages of hamlet, village and city; and artificial towns, which have sprung suddenly into being. In general the plan of the first will be irregular and haphazard; the second, regular and symmetrical.

The topographical site determines the foundation of the city, its geographical position its future development. In early times a position easily defended was of first importance in locating a town, but such locations in times of peace are at a disadvantage and as civilizaton in a country advances such towns are apt to become of less importance. Another determining factor in locating a town is the presence of a great monastery, a church, or some other feature regarded as holy, which offers a moral protection nearly as valuable as the natural protection of a strong position. Economic factors are regarded, of course, as of most importance, but the author confesses himself doubtful as to the extent political factors have been effective, although they have exerted strong influence in certain cases, as has also the character of the inhabitants.

Whatever the origin of a city, its development is always subordinated to its geographical position. In an independent state, the large town must be a center; in a dependent state it must be upon a great line of communication. "When Egypt sufficed to herself, Thebes was her logical capital; from the day when she entered into continuous relations with the other Mediterranean countries, a capital nearer the sea became necessary to her, and Cairo was born."

During the last week in March the Oceanographical Museum at Monaco was opened. The museum, a large and beautiful building, was built by the Prince of Monaco as a place not only to preserve his large private oceanographical collection, but also to provide a place which it is hoped will ultimately contain collections representative of the physics and biology of the ocean in all parts of the world. In addition to a large collection of ancient and modern apparatus for physical oceanography and of specimens of marine organisms, the museum contains an exhibition illustrative of marine industries and extensive laboratories. The museum is to be a part of the school of oceanography recently established at the University of Paris.

The Duke of the Abruzzi reached an altitude of 24,583 feet in his attempt to scale Bride Peak in the Himalayas during his expedition last summer, an altitude which has not before been reached in mountain climbing. The duke lived for three weeks at an altitude of over 21,000 feet, provided with only the barest necessities of life.

Rapid progress is being made, according to an article in a recent *Bulletin of the International Bureau of the American Republics,* in the construction of the Madeira and Mamore Railroad in Brazil. Begun in 1871, this railroad, designed to open up the country above the great falls of the Madeira, has had an interrupted history. In January last 46 miles of the railroad was completed and trains were running, while 154 miles more is graded and nearly ready for the laying of the track. The country to be served by this railroad includes the area drained by the Madeira and its affluents, equal to the area of Texas, and many thousand square miles of contiguous territory in eastern Bolivia, Peru and Brazil, which have no outlet save by the Madeira and Mamore rivers. The railroad will provide an outlet for the present products, rubber and cacao principally, besides mineral resources, and will greatly hasten the development of this large and fertile area.

Among the topics of interest to geographers that are to be discussed at the coming International Geological Congress to be held at Stockholm, August 18–25, are: (1) changes of climate since the last glaciation; (2) the resources and distribution of iron ore throughout the world, and (3) the geology of the polar regions. Several excursions to various parts of Sweden have been arranged to take place, both before and after the meetings.

The location of the new capital of the Commonwealth of Australia has at last been selected. The site chosen is at Cauberra, on the Molonglo tributary of the Murrumbidgee River, in New South Wales, about midway between Melbourne and Sydney. A federal district of about 1,000 square miles surrounds the capital. The leading consideration in the choice of land, for the capital, aside from political ones, was the water supply, which is here believed to be sufficient for all purposes. A port for the city will be built on Jervis Bay, 100 miles east of the federal territory. The present population of the whole district is but 4,000. The site for the capital is nearly 100 miles from the railroad between Melbourne and Sydney, thus necessitating the building of a branch line from this railroad, as well as a road to Jervis Bay.

BOOK NOTES AND REVIEWS

Lyde, L. W. *Man in Many Lands, An Introduction to the Study of Geographic Control.* Pp. 184. Illustrated. London, Adam and Charles Black, 1910; The Macmillan Company, New York. 65 cts. net.

This little volume is an interesting and suggestive discussion of the influence of geographic factors upon human characteristics and activities, written in popular style but intended for school use. As stated in the preface, the book is an attempt to suggest any geographical basis or influence which would help to explain such questions as: why the Swedes invented cream separators; why the Swiss were the first people to adopt conscription; why Portuguese women are so ugly; why the Buddhist color should be yellow, and so on. The author defines "geographic control" as the relation between the organic and the inorganic and says that "it is the special interest of geography to study the action of the inorganic on the organic—the response of the organic to the inorganic control—the full meaning of environment," while the chief interest of history is "to study the reaction of man on that environment."

The book aims to cover the entire world in its few pages—not only the large factors of control, but many minor details. The result is that much of the material is fragmentary and unsupported by facts or reasons. For example, in the chapter on The Homeland (England) the author takes up, along with the question of the distribution of industries, the question of gambling. Gambling, he maintains, is encouraged by the mining industry, which breeds self-esteem, belief in your own judgment and the constant taking of risks. In the London Basin the typical flat-topped areas of the chalk downs with their porous soil provide excellent race courses and here gambling has to do with horse races. In Lancashire, on the other hand, where the topographic conditions are different, gambling has more to do with greyhounds and pigeons and football. When, furthermore, he maintains that industrial Lancashire has given England so many great men because machinery tends to breed, in the uneducated a "bumptiousness" and "cocksureness," yet in the educated a "far-seeing and well-founded self-confidence," the reader questions the soundness of his conclusions.

The following are further typical illustrations of the "controls" mentioned: The "composure" of the Japanese is attributed to the earthquake nature of their country, which has taught the people to face sudden danger calmly. Yellow as the Buddhist color is due to the fact that in all Buddhist lands the plants producing turmeric, a cheap and effective yellow dye, are common. The annual overflow of the Nile brought into the agriculture of the Egyptians "a certainty which not only sapped prudence and industry, but also bred a godless self-confidence which undermined the religious instincts of the people." "The long dark winter nights have made the Swedes, like the Finns, great readers and students; but it seems also to have made them rather slow and too patient." The development of dairying in Sweden and the scarcity of farm labor lead to the invention of dairy machinery, as the cream separator and mechanical milkers.

In spite of some over-statements of the effects of physical control, and many unsupported statements, the reader will find in this little volume many excellent examples of geographic control and much that is interesting and suggestive.

Bingham, Hiram. *The Journal of an Expedition Across Venezuela and Colombia, 1906–1907.* Pp. 287. Illustrations and map. Yale Publishing Co., New Haven, 1909.

Professor Bingham has given in his journal a most delightful narrative of his journey across a little-known part of South America. The expedition was undertaken to explore the route of Bolivar's celebrated march across Venezuela and Colombia in 1819 and the battle fields of Boyacá and Carabobo. The author's route took him from Caracas to Bogata and thence down the Magdalena River to Cartagena. The value of the journal is, however, not merely historical. It gives a vivid and accurate picture of the people and the conditions of life in the two countries crossed and throws much light on the existing economic and political conditions in Venezuela. The part of the journey across the llanos of eastern Venezuela and Colombia is especially interesting, this section being almost unknown to the outside world. The geographer might wish that fuller descriptions had been given to physical features and natural resources, but it must be remembered that the journey was undertaken from the point of view of the historian and not the geographer. The many illustrations from photographs made by the author are a valuable supplement to the text.

Duggar, Benjamin Minge. *Fungous Diseases of Plants.* 8vo, 508 pp. Illustrated. Ginn & Co.

This volume in the Country Life Education Series is designed as a text-book in college instruction, as a guide to the investigator, and for the general reader who is interested in plant production. The first part deals with the technique for the cultivation and examining of parasitic fungi, followed by the important physiological relations of these plants to their environment. The bulk of the book embodies a comprehensive discussion of the chief fungous diseases of cultivated and familiar plants and trees, giving the occurrence, life history and methods of control. The book is profusely illustrated with diagrams and half-tone photographs.

ACTIVITIES OF THE SOCIETY

ELECTION OF OFFICERS FOR THE CURRENT YEAR, 1910–11.

At the annual election of officers, the following were chosen for the ensuing year:

President, Mr. Henry G. Bryant.

First Vice-President,	*Second Vice-President,*
William Libbey, D.Sc.	Mr. Clarkson Clothier.
Recording Secretary,	*Corresponding Secretary,*
Dr. Theodore LeBoutillier.	Dr. Paul J. Sartain.

Treasurer,

Mr. William K. Haupt (elected to fill the unexpired term of Mr. J. Bell Austin, deceased).

Directors,

Miss Rachael P. Barker,
Miss Laura Bell,
Miss Mary Blakiston,
Dr. A. H. Fetterolf,
Mr. Benjamin R. Hoffman,
Miss Mary S. Holmes,
Mr. Alba B. Johnson,
Mr. Charles Morris,
Mr. John G. Rothermel,
Mr. John Sailer,
Henry Skinner, Ph.D.,
Walter Sheldon Tower, Ph.D.

Excursion Committee,

Miss Rachael P. Barker,
Mr. J. E. Burnett Buckenham,
John W. Harshberger, Ph.D.,
Miss Maude G. Hopkins,
Miss E. E. Massey,
Miss Mary S. Holmes, chairman.

Reception Committee,

Mrs. Matthew J. Grier,
Mrs. Theodore LeBoutillier,
Mrs. Charles Roberts,
Mrs. P. J. Rothermel, Jr.

CLIMATIC INFLUENCES IN THE ECONOMIC DEVELOPMENT OF AUSTRALIA.[1]

EUGENE VAN CLEEF.

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INTRODUCTION.

Assurance of a sufficient food supply is the fundamental basis for the continued existence of any individual or community. If the supply be fixed in location then man will tend to remain likewise fixed; if it be temporary then man will tend to become nomadic. The most important determining factor controlling the location of food and its abundance is climate. As an influence in the activities of man climate has rarely been given enough consideration. If analyzed with respect to a given region its importance must immediately be recognized. Australia offers one of the best examples of a region where the entire economic development has been determined largely by its climate.

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[1] Read before the Association of American Geographers, December 31, 1909.

CLIMATIC LOCATION.

Australia lies in the southern hemisphere in latitude 10° 41′ S. to 39° 8′ S.; hence it is cut by the Tropic of Capricorn within 200 miles of a line bisecting it geographically. The island continent may therefore be divided into tropical and subtropical zones. If the planetary circulation of the winds be adopted as a basis for division it may be divided into two parts as follows: (1) That part north of 30° S. latitude, in the southeast trades; (2) that portion south of 30° S. latitude in the region of the prevailing westerlies. The horse latitudes in this region, which logically would appear between the belt of southeast trades and the westerlies, are insignificant owing to the ascending currents of air from the hot desert, largely counteracting the effect of any cold descending currents.

TOPOGRAPHY.

In addition to the location of Australia, which influences so largely its climatic phenomena, the topography should be noted as an important factor in local modifications of climate.

The surface of Australia, generally uniform, is interrupted only by a few hills in the central area and by a chain of mountains of low altitude bordering the eastern coast (map I). This range, called the Dividing Range, extends in an almost due north and south direction, with many spurs running off at right angles toward the interior. No part of this range is higher than 7,300 feet (Mt. Kosciusko in New South Wales); hence these mountains are not complete barriers to precipitation. Most of the range is less than 5,000 feet high and the whole flat interior varies from 3,000 feet down to sea-level.

This distribution of highland and lowland is a very important factor in the distribution of the rainfall and the consequent possible division of the region into several distinct climatic provinces.

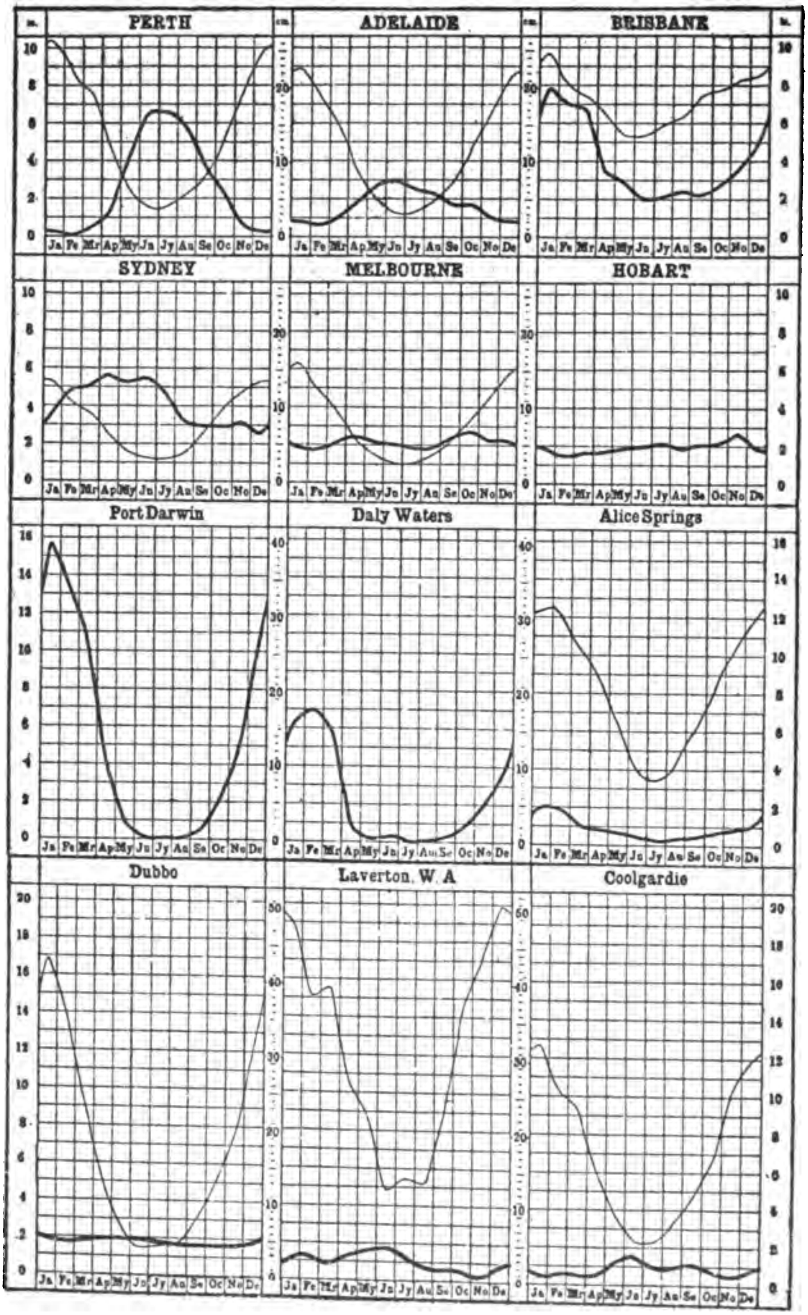
CLIMATIC CHARACTERISTICS.

Temperature.

Australia may be divided into two distinct temperature provinces, namely, a hot interior province and a subtropical coastal province. The transition to a temperate climate which one would encounter at the higher altitudes in crossing the ranges along the coast in New South Wales, may be readily left out of consideration, as applying only to a very small area.

In general, the annual temperature range is not wide; yet an increase in range is noticeable as the desert interior is approached—an area where heating is strong during the day and radiation very rapid at night. The annual variation for the two provinces is strikingly illustrated in Graph 1. The large difference between the curves for Port Darwin on the north coast, a subtropical coastal province station, and Alice Springs, in the McDonnell range, a hot interior province station, is worthy of special notice because it not only illustrates the difference in temperature variation between the two provinces, but presents a clear case of the relative influence of water bodies and land masses upon temperature range. Port Darwin lies on the north coast (map I) where its temperature is moderated first by the northwest monsoon in summer and secondly by the southeast trades blowing out from the desert in winter. Hence its temperature curve fluctuates only slightly. Alice Springs, on the other hand, lies almost in the center of the island (map I) on the eastern margin of the interior desert where radiation is rapid; where, during the winter, winds blow out from the desert tending to disperse accumulating heat, and where, lying in the McDonnell Range, its temperature is further lowered by descending cool mountain air. Its temperature curve, therefore, indicates a rapid descent as the winter season (June, July and August) approaches, and a corresponding subsequent rise as summer approaches.

The hot interior province may be considered as covering an area extending southward to within 125 miles of the coast, westward to a line varying from 125 to 150 miles from the coast, northward to



Graph 1. Annual Fluctuations of Mean Rainfall (Heavy Line) and Mean Evaporation (Light Line).

within 250 miles from the coast and eastward to the extreme western portion of Queensland and the eastern boundary of South Australia. The total area of this vast province is about one million square miles or equal to one-third the whole continent or one-third of the area of the United States. Thus the subtropical coastal province, including about two-thirds of the island area, remains more or less available for development by the inhabitants.

Evaporation.

The evaporation provinces coincide with the temperature provinces:—the hot interior province of high rate of evaporation and the coastal province of relatively low rate of evaporation. Rate of evaporation varies throughout the year, in different years, as well as in different regions. Graph 1 gives the amount of water evaporated per unit area during the year at each of five stations. At Sydney the total annual evaporation is 37.42″; at Adelaide 54.97″; at Perth 65.7″; at Brisbane 86.64″—based on four years' observations. At Laverton in central Western Australia, in 1905 evaporation reached 140.8″ or nearly 12 feet. The rate of evaporation in the interior is so high that water to be preserved for any considerable length of time must be constantly kept under cover, lest it disappear through evaporation.

Relative Humidity.

Just as Australia may be divided into two evaporation provinces, so may it be divided into two humidity provinces: the hot interior province of low humidity and the coastal province of high humidity. In the graph (2) for annual humidity variation, humidity data are given only for the coast stations as no records for the interior are available. Records for interior stations, it is probably safe to assume, would present, if plotted, a flat curve closely paralleling the zero line.

Along the northeast coast the relative humidity is perhaps as large a factor in the oppressiveness of the heat felt there as is high temperature. The real temperature alone is not sufficiently high to cause discomfort; but the constant high humidity as indicated in Graph 2, combined with the high temperature makes hard work during the greater part of the day impossible. It is not until the regular afternoon sea-breeze sets in, that relief from these enervating conditions is brought about.

Rainfall.

Again two provinces may be named. As before, one is the hot interior province of little or no rainfall and the other, the coastal province of fairly heavy rainfall (map 2). It is possible to introduce a third or transition province of intermediate rainfall, but this may be readily consolidated with the coastal province.

Graph 1 indicates the annual fluctuation in rainfall for several type stations, Alice Springs and Coolgardie representative of the interior with totals for the year of 8.9″ and 10.8″ respectively; and Sydney and Port Darwin typical coastal stations with 48.8″ and 61.5″ respectively.

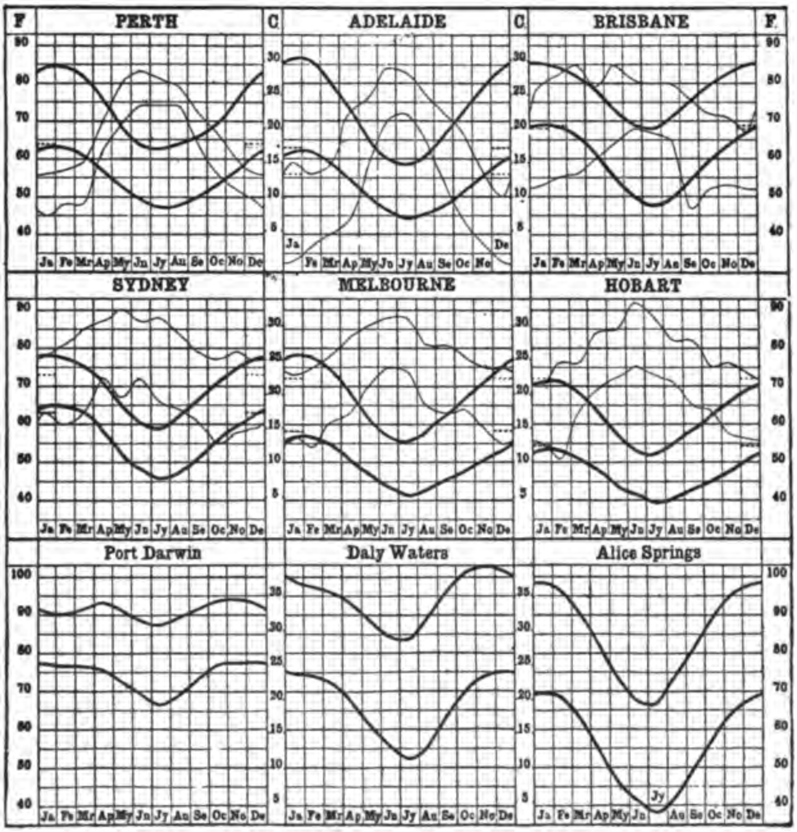
This distribution of rainfall results from several causes. The southeast trades blow along the east and the northeast coasts precipitating their moisture on the flanks of the mountain ranges along the coast and only a short distance inland as far as 30° S. latitude. On the northwest coast the trade winds have already passed across the interior and hence, being dry winds, precipitate very little. The westerlies add some moisture to the coasts of the southerly extensions of the continent.

The northwest monsoon, when it is strong, brings a large amount of moisture to the northwest coast. But this monsoon cannot always be depended upon, as some years it fails to cause much precipitation while during other years it is instrumental in the occurrence of enough rain to give exceptional crops in otherwise poor areas. This variation in effect on rainfall is not thoroughly understood; it seems to be due to the varying intensity of the semi-permanent high-pressure area in the monsoon regions.

Other factors besides the winds of the general planetary circulation influence the amount and distribution of the rainfall. The land mass lies in the path of cyclones of the South Pacific. These cyclones pass across the southern portion of the continent carrying inland large amounts of water vapor from the sea.

Graph 2 illustrates the annual distribution of rainfall for different localities, a few of which may be noted. At Perth, on the west coast, the maximum rainfall occurs in the winter months (June to

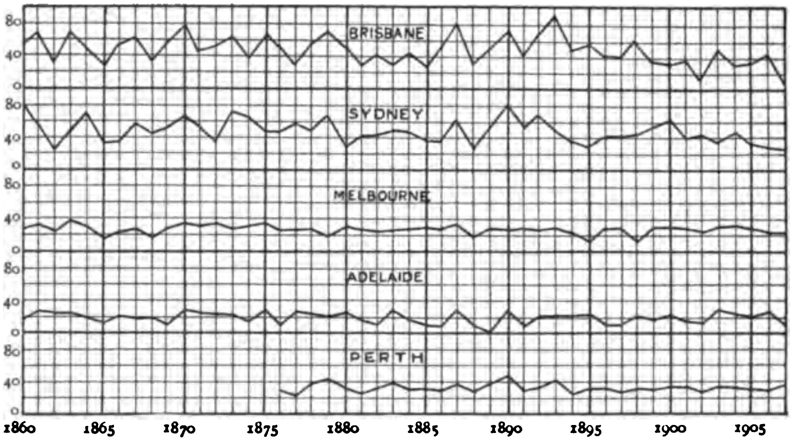
September); at Brisbane and Sydney on the east coast it occurs in the autumn (March to May), and at Port Darwin on the north coast an extreme maximum is reached in the summer (December to February). The wettest place is at Geraldton on the northeast coast



GRAPH 2. MEAN MAXIMUM AND MINIMUM TEMPERATURE (HEAVY LINE) AND HUMIDITY (LIGHT LINE).

of Queensland, where a maximum of 211.2" and a minimum of 69.8" have been recorded. The driest region is in the vicinity of Lake Eyre in South Australia, where the normal annual average is 5 inches and the maximum annual average rarely above 10 inches.

Although the general distribution of rainfall has been cited above and annual averages presented, attention must be called to the great secular variability in rainfall (Graph 3). Australia is subjected to periods of severe drouth alternating with normal, and even at times, abnormal precipitation. Drouth occurs frequently. It is not always widespread over the continent; in fact it usually visits only small portions of the land and then at intervals of three or four years or sometimes fifteen or twenty years. Its place of occurrence cannot be foretold; its arrival, its duration and its severity are all uncertain quantities. Observations for a period of years seem to point to a twelve year rhythm for the re-occurrences of the drouth.

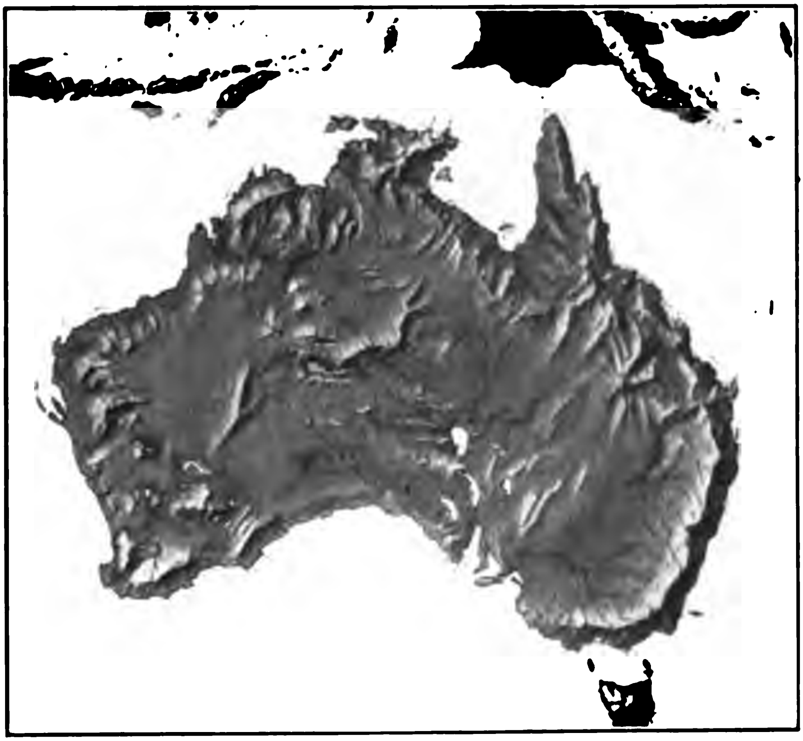


Graph 3. Secular Variation in Rainfall.

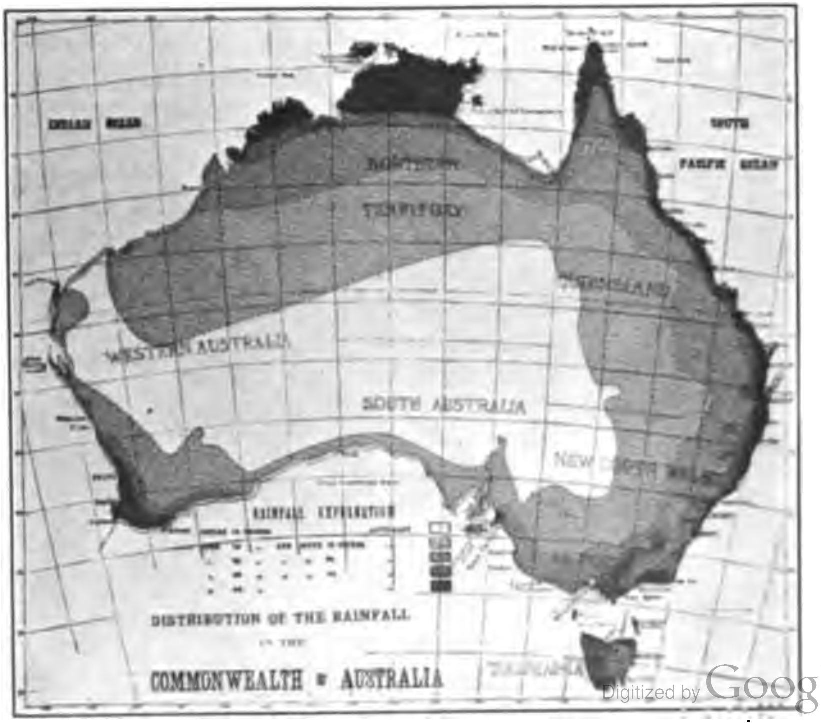
The extreme southern extensions of Australia and Tasmania can be certain of rainfall from one set of winds only, namely the prevailing westerlies. The other sources upon which Australia is wholly dependent for precipitation over the entire land, namely, the monsoon, the cyclone and anti-cyclone, the latter a feature of the permanent planetary high pressure area, are not reliable. They shift either north or south, or fail to appear at the proper time, or cause excessive rains; accordingly the Australian can never tell just how much or how little rain is coming.

Periodic and Aperiodic Winds.

These winds are both beneficial and detrimental to the Australians. They are more or less local in effect and hence cannot be treated by



Map 1. Relief Map of Australia.



Map 2. Distribution of Rainfall.

provinces. Their treatment cannot be omitted, even though they may seem to be minor details of the larger factors influencing Australia's climate.

Land and Sea-breeze.—During the summer days along the east and west coasts, when the afternoon temperature has risen considerably, the sea-breeze which sets in as a result of the local gradient established between the relatively cool air over the ocean and warm air over the land, often attains a velocity upwards of 30 to 40 miles[1] an hour. It penetrates inland from 9 to 12 miles. This sea-breeze effect comes as a great relief to the inhabitants. It is surprisingly regular, occurring about 3 P.M. each day. In many cities on the coast, the single control and support of the energy of the native is the knowledge that about 3 P.M. a cool breeze will bring relief after the humid oppressive heat of the day. Without this breeze the north and east coasts would very likely be as nearly undeveloped as the interior; indolence would then characterize the inhabitants of these coastal areas.

Cyclones and Anti-cyclones.—The cyclones in Australia vary in size from large, regular, slowly moving, extra-tropical storms to severe tropical hurricanes. They are rare; in any case not more than one or two appear in two or three months (from December to March). Their paths are generally from a northerly direction toward some southern point. Their paucity is occasioned by the presence of the nearly permanent South Pacific high pressure belt which for the greater part of the year controls the atmospheric conditions over Australia. These storms are nearly always accompanied by very heavy precipitation. However, their irregularity detracts somewhat from their value as rain producers. The high winds, almost tornado-like in force, which accompany these cyclones endanger ocean traffic especially.

The anti-cyclones appear regularly; about 42 cross the continent each year, a few more in summer than in winter. These high pressure areas are for the most part characterized by good weather.

The Southerly Burster.—This wind is typical of the eastern part of Australia. It is a cooling wind which apparently is a part of the inflowing winds of a low pressure area which travels at a very rapid rate. This cool wind induces precipitation over the land and hence is of much economic significance. The burster appears frequently, though without any prescribed regularity; sometimes two follow in one day; at other times a month may elapse without any burster. August to May are the months of greatest frequency. An absence of these bursters is considered by the Australians as an omen of coming drouths. This can be readily understood when it is known that they break between sundown and midnight, thereby checking the heat of the day, and furnishing the parched soil with moisture; and that their failure means heat accumulation during successive days resulting finally in severe drouth.

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[1] "Official Yearbook of the Commonwealth of Australia," 1901–1908, p. 142.

Hydrology.

The hydrology of Australia may be consistently treated by provinces, namely the hot interior province of no rivers and a few semi-permanent lakes; and a coastal province of many short streams and a few long rivers.

Rivers.—Permanent river systems are rare in Australia—clearly a result of the scarcity of rainfall and general high rate of evaporation. There is but one large system, that of the Murray River, of which the Darling is a branch of important size. It is located in the southeast section of the country. These two rivers are the only rivers in Australia which can be depended upon to be navigable the greater part of their length practically throughout each year. The Murray is 1,720 miles long and is navigable for 1,590 miles during good rainy seasons; the Darling, including that part of the Murray below the junction of the two, is 3,282 miles long and during the best rainy seasons is navigable for 2,345 miles.

The aridity of the climate is again illustrated in the entire lack of even so much as an intermittent stream entering the ocean for 1,000 miles along the southern coast from Spencer westward to King George Sound. What little water falls either evaporates or sinks into the soil at once.

Lakes.—After a consideration of the rivers, it is natural to conclude that lakes are scarce and small. The Eyre, Torrens and Gardner lakes in the state of South Australia are the largest and most significant. They are shallow and during dry seasons become morasses or even dry up entirely leaving "a cracked surface of salt and dry mud."[2] Lake Eyre is a few feet below sea-level. Such semi-permanent salt lakes are of practically no value to the country but rather a handicap. The water cannot be used for irrigation as its salts are destrucive to vegetation; it cannot be used for drinking purposes—hence it is practically useless.

Artesian Basins.—Artesian basins have been discovered recently in the northeast part of the country. To some extent they figure in the production of crops. Although 569,000 square miles is the area of the basin, the water which it furnishes is largely salt or contains other mineral matter detrimental to its use for irrigation. However, some wells have furnished suitable water for vegetation, other water for stock, or for wool-scouring. The uncertainty of the rainfall causing an uncertainty in supply of water in the basin and therefore uncertain duration of flow of the well makes dependence on these wells for irrigation purposes rather hazardous. If the supply of water cease just when the farmers' crops need it most, the loss to the farmers is necessarily tremendous.

Desert.—Almost the entire west half of Australia is a desert—the narrow strip (about 150 miles wide) of land bordering the Indian ocean being the only portion which has a sufficient supply of moisture to exclude it from the category of desert. The desert in the "dead heart of Australia" is in some respects worse than the Sahara for there are no oases to permit of cultivation on even a few acres of soil. In the oases of the Sahara the date palm "grows in dense groves;"[3] wheat occupies 20 per cent. of the land along the Nile just above the delta, largely the result of irrigation. Such growth of flora is unknown in the Australian desert.

NATIVE FLORA AND AGRICULTURAL PRODUCTS.

Looking at a rainfall map and keeping in mind the nature of the topography and the distribution of the rainfall one may well surmise the character of the native flora. Coinciding in distribution as it does with the rainfall provinces, it grades from the desert types of the hot interior province and its border, to subtropical types in the coastal province at or near sea-level. At high altitudes in the southeast portion are a few temperate types.

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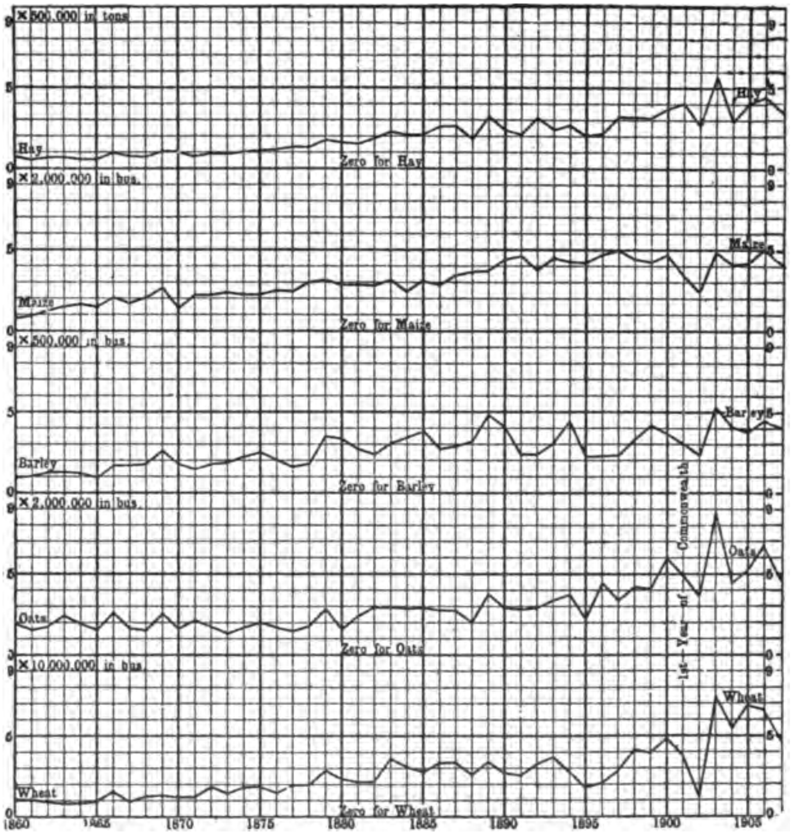
[2] "Official Yearbook of Australia," 1901–1908, p. 70.

[3] Mill, "International Geography," p. 922.

Of the vegetation introduced by man, wheat, one of the best resources, grows principally in the states of Victoria, New South Wales and South Australia.



GRAPH 4. PRODUCTION OF PRINCIPAL CROPS, 1860–1907.

Oats, barley and maize grow in scattered areas along the east coast, Victoria leading in the output.

Sugar cane and the grape, the former a vital factor at one time as an influence in political events, occupy small areas on the east coast. Fruits of many varieties find a place nearly everywhere in the cultivated regions. Coffee, hops, tobacco and cotton form the minor groups of vegetation.

Under normal climatic conditions the above products form excellent crops. Unfortunately, however, drouth primarily, and flood at times, always make successful crops an uncertainty (Graph 4).

Graph 4, showing production of various important crops from 1860 to 1907, compared with Graph 3, showing rainfall for Victoria, New South Wales and South Australia for the same period, parallel each other almost exactly.

In Graph 3, showing variation in rainfall, it will be noticed that in the years 1864–5, 1880–1, 1890–1 and 1900–1, a decided drop in the curve occurs, indicating decrease in rainfall for those particular years. Compare these fluctuations with those in the curves for production, Graph 4, and similar fluctuations will be seen for the years 1865–6, 1881–2, 1890–1–2 and 1901–2; in each instance the fall in production takes place one year after the decrease in rainfall.

NATIVE FAUNA AND PASTORAL PRODUCTION.

Faunal distribution coincides with floral distribution. The most important animals affecting the economic development of Australia, namely, sheep, cattle, horses and pigs, are mostly confined to the valleys of the river systems in the southeastern states. The valley of the Murray-Darling system in New South Wales is the area of largest production. New South Wales leads all other states in sheep production, while Victoria and Queensland rank next with a rather high output.

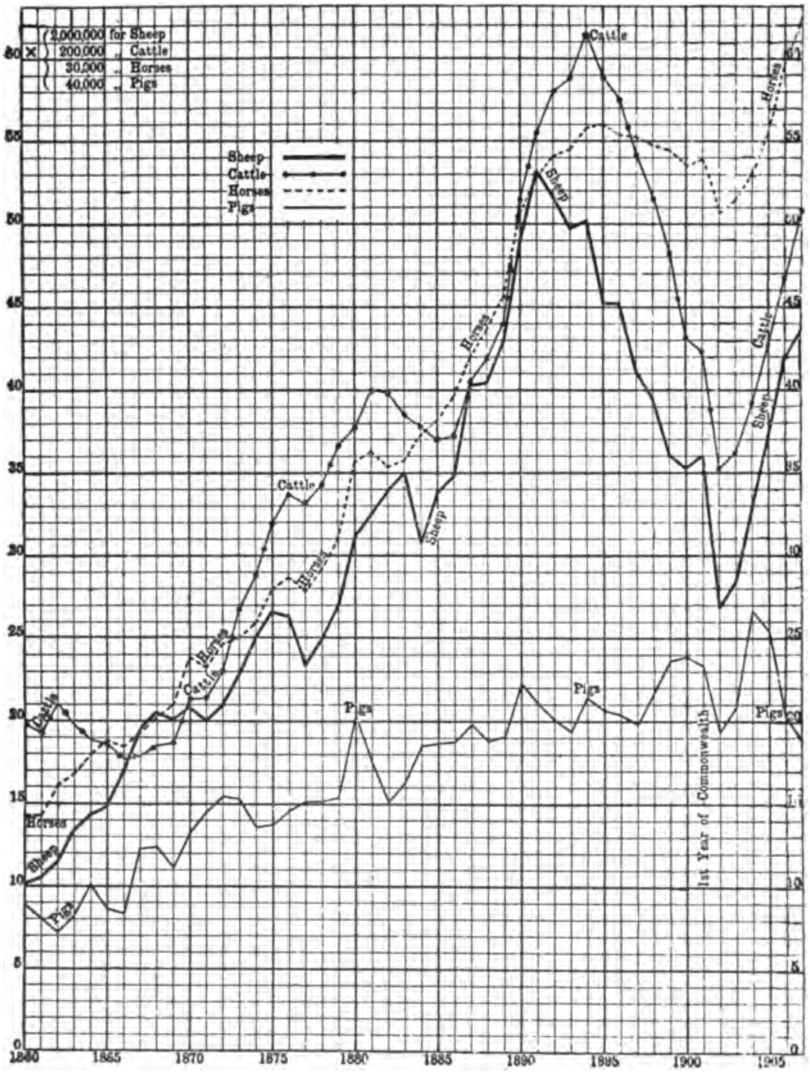
Cattle are more evenly distributed; Queensland, New South Wales and Victoria are the largest producers.

Horses appear wherever cattle are. In addition large numbers graze in the semi-desert areas of South Australia and western Australia.

Pigs are confined principally to New South Wales, Victoria, Queensland and South Australia.

Rabbits have played their part as an obstruction to progress and still remain a pest in the southeastern districts, although they are utilized to some extent as an item in the export meat trade.

Comparing variability in rainfall with that of animal production the same parallelism is seen as that between rainfall and agricultural production (Graphs 2 and 5); in fact the response is even more vivid.



GRAPH 5. NUMBER OF HORSES, CATTLE, SHEEP AND PIGS, 1860–1907.

PRODUCTION AND DROUTH.

Many minor and major drouths of more or less severity have effectively influenced the history of Australia, only a few of which, however, will be detailed as illustrative of the seriousness of an abnormally fluctuating rainfall.

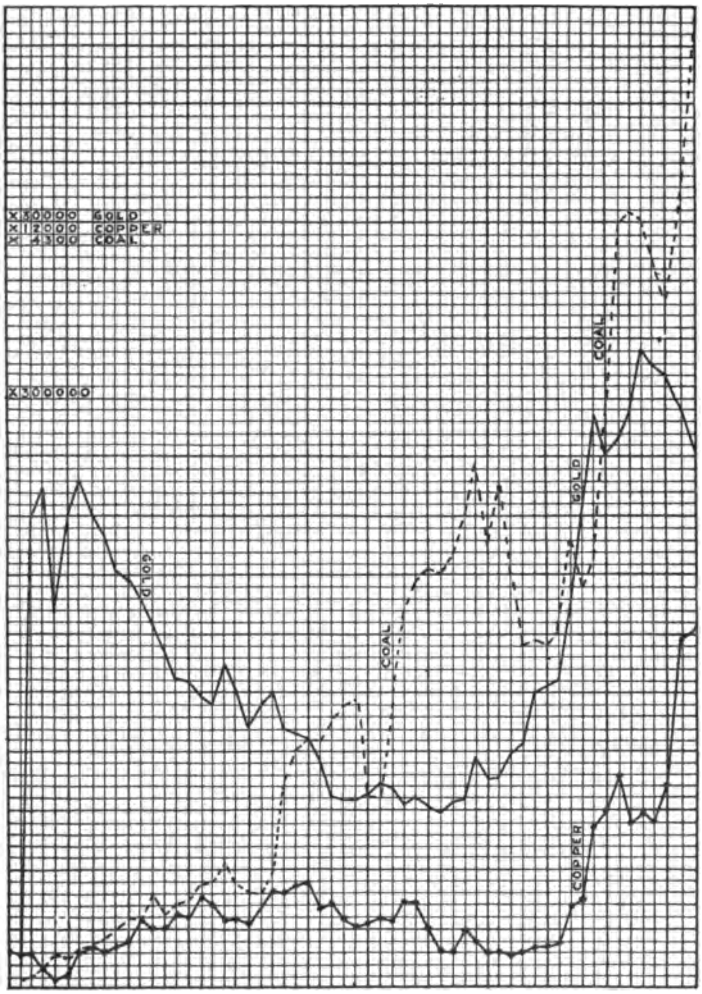
In 1838 a drouth began to spread over the country, increasing in intensity in 1839 and lapping over into 1840. Prices of commodities rose at once. Wheat at Sydney sold for twelve shillings ($3) per bushel; flour cost £30 to £40 ($150 to $200) per ton and a four pound loaf of bread cost 37 cents.

Though this drouth did widespread damage and worked extreme hardships on every hand, it, at the same time, caused the rise of a new industry which since has proved quite profitable. Sheep sold for one shilling per head. This meant a surplus of practically valueless sheep and hence a tremendous loss to the owners of sheep, as well as dealers in wool.

Someone conceived the idea of converting the fat of the sheep into tallow. Thereupon the prices rose to 3 and 4 shillings per head; 5 to 6 shillings worth of tallow was secured from each sheep. A call for shepherds and agricultural labor arose. Thus a partial relief was established. However, many people were hard pressed and of these a large proportion emigrated.

In October, 1857, a drouth set in, lasting until February, 1858. It played havoc with the welfare of the country until the end of 1858, when gold was discovered at Burrangong in Queensland. Thousands were attracted. But a striking situation arose. The Chinese were attracted from the north by the lure of the gold. There was only a small quantity of food available as a result of the drouth conditions. The Chinese fared well, for they could live on a minimum amount of food, whereas the European needed a large quantity. The success of the Chinese so angered the Europeans that riots and general disorder ensued which was not settled until the Chinese were exiled from this section by the governor of Queensland.

After 1872 a bright period in the economic development of Australia shone forth. For thirty years the climate remained constant; no drouth or flood interfered with the steady up-building of the various states, except a local unimportant dry spell in New South Wales in 1885–7. As the inhabitants expended every effort to establish themselves upon a firm basis, agriculture spread, cattle breeding increased and sheep grazing extended in several directions. As gold mining also increased at a steady rate, railroad construction revived. Money became so plentiful that it was spent wastefully. Prices of foods and merchandise were inflated; wages were also

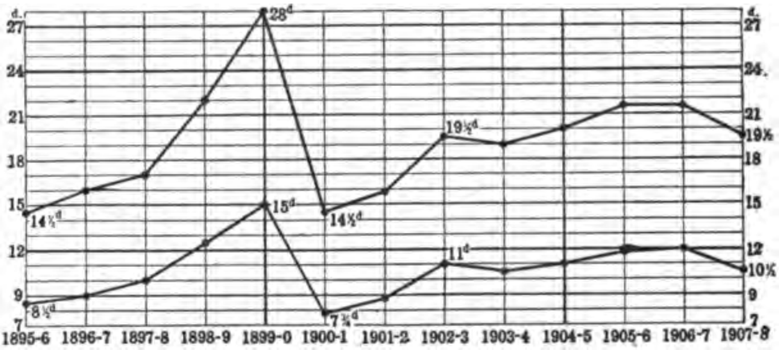


GRAPH 6. VALUES OF PRINCIPAL MINERALS.

increased. Much speculation in the mining fields was carried on until in 1891–3 a crisis came. The state governments had become so heavily indebted that they could no longer borrow nor could they pay back. During the gold frenzy agricultural exports had decreased and agriculture in general had been neglected. Now, the states realized, the only manner in which to relieve their situation would be by increasing their exports. It is interesting to note that while the wastage of money and general speculation ruled the urban population, the farmers had raised sufficient crops to support themselves, so that upon the arrival of the crisis they withstood it easily.

The above account well illustrates the double influence of the drouth. On the one hand the unusually long period of excellent weather conditions following a series of alternating drouth and normal conditions gave agricultural occupations a new impetus and afforded the mass of the people work, food and wealth. The accumulation of this wealth allowed an unusual surplus to a people *inexperienced in handling large sums of money,* which in turn encouraged reckless spending. On the other hand with the coming of the crisis the climate still favored the production of good crops and so saved the country from a more severe shock than it otherwise might have suffered.

From 1900 to 1903 eastern Australia met with a prolonged drouth which was attended by more than the usual desiccation and



GRAPH 7. AVERAGE PRICES OF AUSTRALIAN WOOL, 1895–6 TO 1907–8.

destruction. Even copper mines which had been turning out great wealth were forced to cease operations owing to the lack of a water supply—an excellent illustration of the influence of varying rainfall upon the development of the output of mineral resources. The total effect of this dry period is best observed in the graphs showing production, Graphs 4, 5, 6. The sudden drop in all the curves at this time testifies to the kind of response.

Graph 7 shows the influence of the drouth upon the price of wool. As on previous occasions the production of sheep decreased—this time however even more than usual. A decrease in the supply of a product ordinarily means increased cost of that product. In this instance however, the drouth produced diseased sheep and therefore the sheep, though few in number as compared with numbers during normal periods, were practically worthless. They became so poor, nearly starved, that their wool was reduced in quality. Hence though the wool was scarce as a result of reduced numbers of sheep, its quality, in turn, did not warrant a high price. At this time the lowest prices on wool in the history of the country were recorded. Thus, another striking response to climatic influences is illustrated.

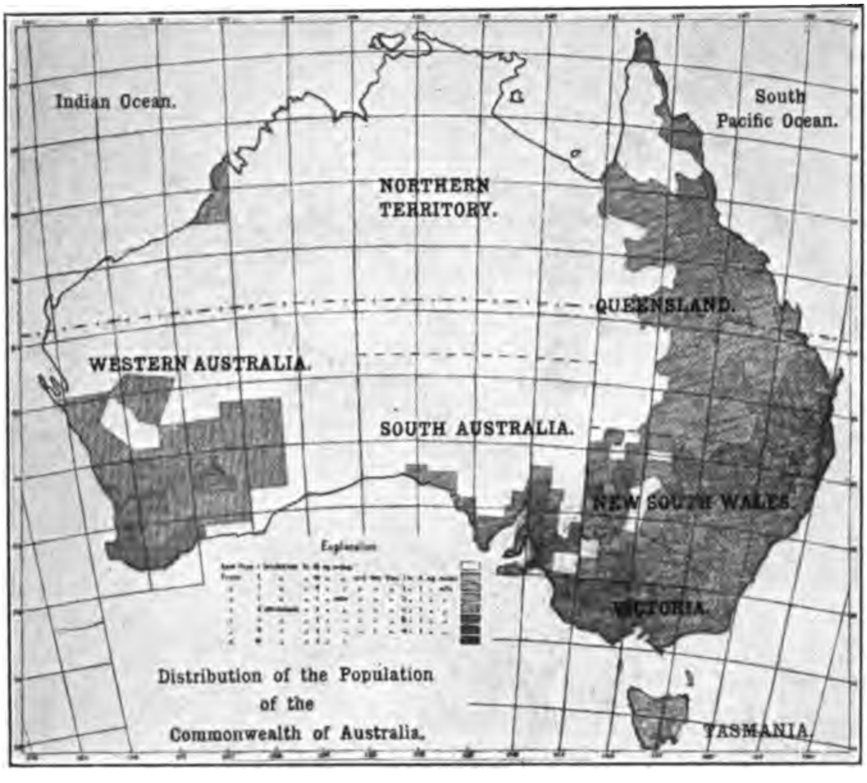
POPULATION.

Aborigines.—The influence of climate upon the aborigines of Australia furnishes one of the best examples of such an influence on a primitive people. These aborigines are the lowest type of man on earth. They have not yet reached the "stone age in the history of development."

In certain regions about the north-central interior, the aborigines have a "decided distaste for agriculture" and accordingly live on animal food. Their distaste for agriculture probably arose from the fact that crops are very hard to raise, first because of deficient rainfall (5″ to 10″), and secondly, because the frequent recurrence of drouth is most discouraging to any attempts at agriculture. Hunting becomes the chief occupation under such circumstances. A nomadic life results.

In contrast with the lowest type are found natives only a step further advanced, who live just on the outskirts of the territory of the lowest aborigines. Here in southern and northern Australia near the coast line in districts where the rainfall is sufficient to permit of somewhat extensive cultivation, in a region where the water supply approaches permanence, where drouth is less frequent and less severe, agriculture is invited and life is largely sedentary.

Colonization.—A struggle for existence, within certain limits, promotes progress; but in Australia where the limits have reached



Map 3. Distribution of Population.

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too great extremes, the native has been overcome by his own environment, before he could possibly overcome it. Considering the conditions which the aborigines faced, the European immigrants certainly did not have an attractive field to enter. Just as the native inhabitants found their life one continuous struggle owing to the very unstable climate, so, for the same reasons, the colonists, in general, found Australia a region full of handicaps.

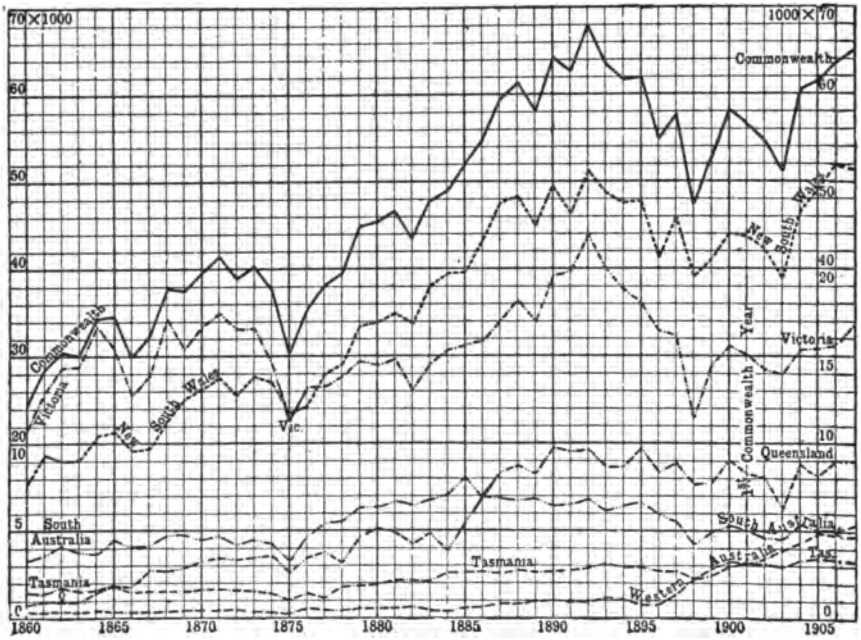
From the very earliest settlements in 1788, sent out from England in 1787, until today, the colonists have been governed in their various activities by the variability and peculiarities of the climate; not influenced unconsciously, but so knowingly that they have always had to formulate plans and prepare campaigns in order that they might cope successfully with the climatic elements.

Distribution of Population.—The control of rainfall over the distribution of vegetation, expresses itself in the present distribution of the population of Australia. The map (Map 3) showing density of population clearly illustrates the tendency toward the establishment of settlements along the coasts. Their distribution is so marked that again the two province division may be resorted to, namely, the hot interior province with almost no inhabitants, and the coastal province with nearly all of the inhabitants. The native tribes, about 30,000 in 1901, comprise almost the entire interior population. In the eastern section of the continent the population decreases from 16 per square mile on the coast, to 1 per 16 square miles 450 miles inland. In the extreme southwest the same rate of decrease holds. In the remainder of the continent the land is so sparsely settled that a scale of density is not attempted.

Distribution of Cities.—A political map of Australia shows a black border of type. All of the important cities and nearly all of the less important are located on the coast. Ordinarily the first reason assigned to such a location would be proximity to a water body affording excellent facilities for communication with foreign peoples and easy coastal trade. This reason is partly good here; but there is another one. In the United States the early settlers did not remain on the Atlantic coast but spread across three thousand miles of territory within one hundred years after the Declaration of Independence, and founded cities ranking in importance and size above many of those on the coast. During the hundred years of

Australian organization the interior has hardly been touched because its climate has been an effective barrier. In the United States the settlers were invited into the interior by the exceptionally fine soils and grazing lands. In Australia a desert stared the people in the face. Nearly one-third of the Commonwealth is pure desert and practically uninhabitable; another third is unreliable for cultivation.

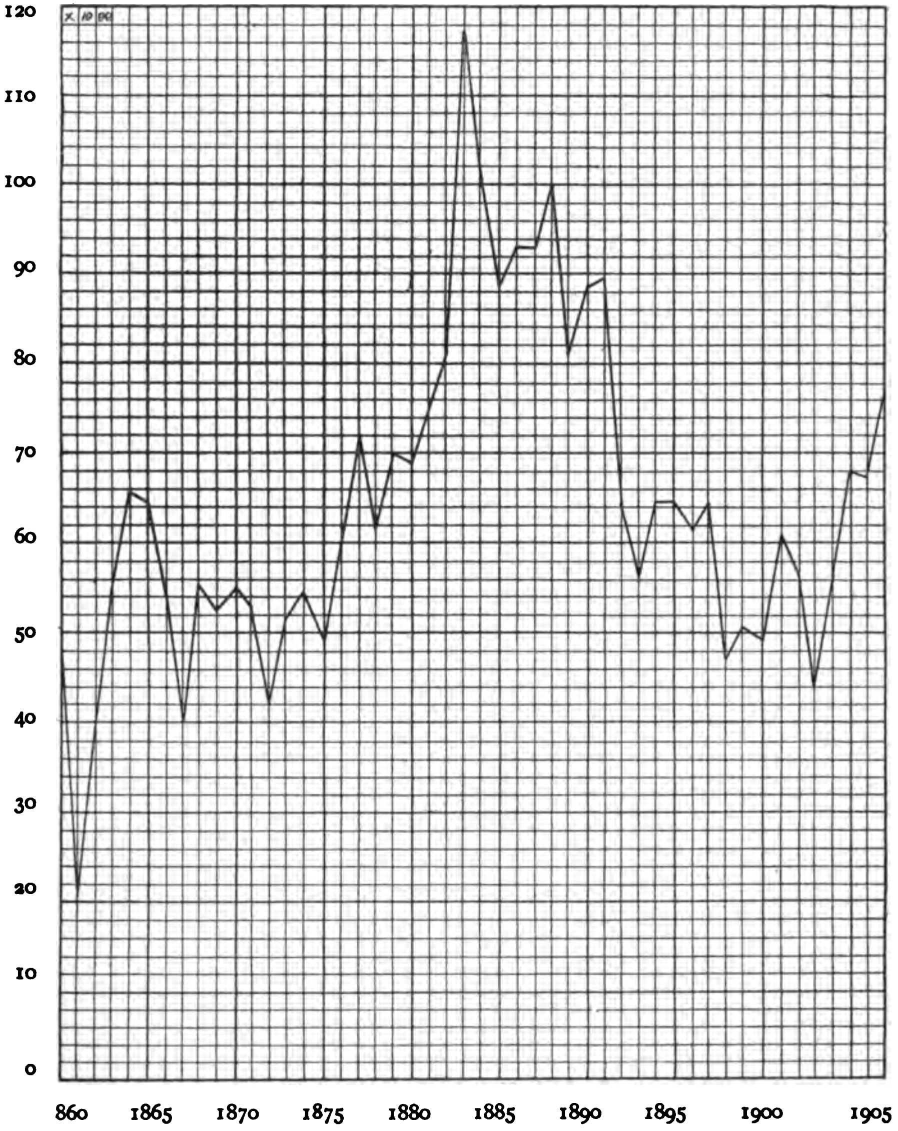
Inasmuch as the food supply has always been near the coast, and inasmuch as communication across the desert has been impossible until recently, the densest population has always been on the coast and the cities accordingly have been founded where the population has located.



GRAPH 8. NATURAL INCREASE OF POPULATION.

Growth of Population.—The drouth has been instrumental in the variation of the growth of population. A drouth-visited country does not invite immigration; on the contrary, it encourages emigration. Unless prosperity is reassured few emigrants return.

Drouth reduces materially the natural increase in population. In



Graph 9. Net Increase of Population of the Commonwealth.

order that natural increase of any living organism be maintained normal conditions for life processes must remain at least constant.

Climate certainly influences not alone the character of vegetation and lower animal life, but the rate of reproduction. It seems evident that climate should affect the growth of human population, merely a higher form of animal life, as it does the growth of any of the lower forms. (Graph 8.) It has been suggested[4] that the relation between birth rate and drouth conditions is very close; that the laboring classes give rise to greater natural increase than other classes and hence drouth, reducing the laboring classes, thereby reduces the source of greatest reproduction. Figures have been presented to demonstrate the validity of this assertion.

Graph 9 is an expression of periods of alternating drouth and normal conditions. During good times the curve rises; during or just after drouth it falls; gold discoveries may produce upward starts, but drouth and subsequent financial crises send it down again.

INDUSTRY AND COMMERCE.

Australia was not without its industrial difficulties. These difficulties arose either directly or indirectly as a result of climatic influences. A critical situation is here cited.

After the Commonwealth was established (1901) it narrowly averted destruction as a result of the labor difficulties in the sugar-cane growing industries in New South Wales and Queensland, the only states in which the cane is grown. For years previous to the federation of the states, kanakas (blacks) from the neighboring islands, were employed as laborers in the cane fields. When the conditions of union were drawn up one of the provisions in the so-called Pacific Island Laborers' Act (1903), limited the number of kanakas which might enter the country up to March 31, 1904; and further, after 1906 when all contracts between the employers and the kanakas would cease, no more blacks would be permitted within the country.

In order to encourage white labor excise dutes were fixed as follows:

EXCISE ON SUGAR.[5]

Grown with black labor £3 per ton.
Grown with white labor £1 per ton.

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[4] "Childbirth in New South Wales," T. A. Coghlan, statistician of New South Wales.

[5] "Yearbook of Australia," 1903, p. 797.

Queensland was absolutely dependent upon the black labor, especially in the northern part where tropical conditions exist; whereas New South Wales could readily dispense with their services and substitute white labor. If the blacks continued to produce the sugar in Queensland and the whites in New South Wales, the former would lose money owing to the excess duty of £2 per ton. Naturally Queensland entered a protest. The question then arose as to whether Queensland, the two states Queensland and New South Wales combined, or the Commonwealth should bear the extra cost of production where the kanakas had to be employed. The two states of course did not wish to pay the cost of black labor exclusion. After a discussion of various schemes for the distribution of the excise duty the problem was finally solved whereby certain bounties were paid out of the Federal Treasury to the producers of "10 per cent. quality of sugar cane" grown by white labor. Thus all of the states shared a proportional duty and the two states marketed their products at the same prices. Co-incidentally a high import duty was placed on foreign sugar so that all of the non-producing states were practically compelled to buy the home product.

The above condition of affairs is related at some length owing to the fact that this situation in 1902–3 in Australia, almost paralleling in its nature that in the United States previous to the Civil War, grew directly out of the facts, that only a portion of the country was favored with a climate permitting the growth of sugar cane, and that *in* that portion the climate controlled the nature of the labor that could be employed. Thus climate was a potent factor in nearly upsetting the Commonwealth and at the same time no less influential in establishing among the states a recognition of each other's rights.

Location.—Australia's location does not favor a rapid development of its resources. It lies on the south side of the equator and therefore a very large fraction of its commerce must cross the equator in order to reach its best markets which are located in the northern hemisphere. Before the introduction of refrigeration shipments of fresh meats and fruits to the northern markets was impossible; after its introduction the price of sheep[6] increased—a response to the extension of the market; the industry of sheep grazing was remarkably stimulated. Apple growing received an impetus; Australian apples are of exceptional quality and find a ready market in the United States, Canada and England, to which countries quantities valued at $865,950 were exported in 1906. Had Australia been in a corresponding latitude on the north side of the equator her export trade would have developed at a very early date.

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[6] In 1880 the first shipment of meat arrived in London.

CONCLUSION.

In the effort here made to demonstrate that climate has been a controlling factor in the economic development of Australia, the alternations in the periods of drouth and normal conditions have been made paramount. So long as Australia's mineral resources are limited and manufacturing is therefore at a minimum, the country must be absolutely dependent upon the soil. The soil is the prime factor in bringing returns to the people. The production from the soil is dependent upon the climate, especially where irrigaion is impossible as it has practically proven to be in Australia.

The coming and going of the drouth, an expression of the variability of Australia's rainfall, has checked immigration; it has caused emigration; it has influenced the working of the mineral resources, decreasing the output of the mines; it has checked the construction of country roads, railroads, structures for commercial enterprises, homes—in fact it has interfered with all constructive works. The drouth has nearly ruined the country tending to produce continual strife among the inhabitants; at the same time it has perhaps saved the country by forcing the inhabitants to recognize that in *their* union strength would lie, and thus has brought about their federation into the "Commonwealth of Australia."

The discovery of a method whereby irrigation may be possible will mean Australia's freedom from the destructive drouth and will offer opportunities for continued progress, on a limited scale.

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CLIMATE AND MAN IN PERU.[1]

Dr. Lucy L. W. Wilson.

II. The Sierra: The Andean Region.

From the dry and narrow coastal plain of Peru, the land ascends in slopes and terraces to a Maritime Cordillera. This is separated by erosion from what is called the Central Cordillera. Between the wild and rugged mountain chains with broad ridges of the Maritime Cordillera and the needle-tipped Andes is found the region known as the Sierra. To the people on the coast the word Sierra is applied to all the plateau and mountain region above them. Many geographies prefer to call the more desolate regions the *Puna* and reserve the word Sierra for the more fertile valleys which in former times were the strongholds of the Inca Empire.

Climate of the Sierra.

The climate of the Sierra, using the word in its broadest sense, is equable; but it differs from that of the coast in that there is, nevertheless, a well-marked rhythm both in temperature and rainfall. The southeast trades are not robbed of all their moisture by condensation on the western Andes; still, as the subjoined graphs show, they become drier and colder as they move northwestward over Peru. At their weakest, in our summer months, they bring very little moisture to the Sierra.

The colder season of the year is the dry season, but the mean monthly variation in temperature is comparatively smaller. The greatest temperature variation is diurnal. Not less striking is the difference in temperature between the shady and sunny sides of the streets. The lower valleys of the Sierra are markedly warmer.

Plant Response.

Because of the long dry period and the absence of underground water, there are no forests on the Sierra.

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[1] Continued from the July number.

The marked rhythm in the rainfall has induced here as elsewhere, two adaptations to enable the plants to survive the drought: (I) A storage habit, illustrated by the potato, the oca (edible root of *Oxalis tuberosa*); (II) hard and horny seeds enabling the plant to await successfully the coming of the rain, as for example, quinua, corn.

Potatoes are still found growing wild in Peru, but they were a domesticated plant even in the time of the Incas. The Peruvian white potato of the present day is a very small affair, not to be compared with its modern European and American descendants. There is also found there a yellow variety, also small but quite mealy. It is good enough although I cannot agree with the statement of a traveller that "it is without an equal."

The Peruvian national dish is a stew of meat and potatoes, made possible by the climate of the Sierras. The air is so dry and the sun so hot that meat is easily dried ("jerked") there and will even bear transportation to somewhat moister climates. The potatoes have every bit of moisture taken out of them by alternate freezings and thawings. This is easily accomplished by reason of the great difference between the night temperature and the temperature in the sun. Unfortunately, all the flavor is taken out of the potato as well as the moisture. However interesting it may be at first to discover that the hard white round marbles of the market are potatoes plus climate yet, after a while, the tasteless daily stew ceases to make even a mental appeal and one longs for food, plain simple food, even without climatic interest, if only it has some taste.

ANIMAL RESPONSE.

The animals of this region show very markedly their adaptation to the absence of forests and the almost desert-like conditions that prevail during the summer months. They are all fleet of foot, as they must be to escape from enemies in the open. The most important ones, the vicuna, guanaco, alpaca, belong to the camel tribe and, like them, can browse on the harshest herbage, swallowing it whole and regurgitating it at pleasure, or, to be more exact, when the food supply is exhausted and there is leisure for mastication.

The llamas were domesticated when the Spaniards came to Peru. The domestication may have been accomplished by Pre-Incaic people. At any rate, it is an evidence, along with the numerous domesticated plants, of the fact that ancient Peruvian civilization was not a mushroom in growth.

It is a significant fact that when their neighboring race in North America had not one single domestic animal, the ancient Peruvians had not only the llama and the alpaca, but also dogs and guinea pigs, and made pets of the birds.

HUMAN RESPONSE.

Two cities of the Sierra illustrate well the whole story of the interrelation between man and climate. Both are large and populous. In the one case the population is transient, foreign, disorderly; in the other, the people are more or less homogeneous, largely native, and always law-abiding. In the one case, man has triumphed over climate because the reward is great; in the other, climate has enabled man to triumph.

The first town is the famous, and at times infamous, Cerro de Pasco, oftenest large and prosperous, although sometimes absolutely deserted and even now facing the certainty of future desertion.

Cerro de Pasco lies in a basin-shaped hollow. It is swamp infested, surrounded by bleak and barren rocks, cold, remote, solitary, so high that active work is difficult, dangerous even, except to the indigenous. No better illustration exists of the one lure which induces man to defy climate. The infertile soil covers mineral wealth apparently boundless.

The other city is Cuzco, the rich and beautiful capital of a wonderful people, always inhabited, always beautiful, and with perhaps its greatest development still in the future. Already the railroad from the coast has reached it. Sometime the long-dreamed-of road to a tributary to the Amazon will give it communication with both oceans.

At the time of the Conquest, Cieza thus described Cuzco:

"In other parts of the kingdom the people lived in houses scattered about, and if there are some villages, they are without plan or order or anything worthy of praise. But Cuzco was grand and stately and must have been founded by a people of great intelligence. . . . The climate although it is very cold, is very healthful, and Cuzco is better supplied with products than any other place in the kingdom.

"Near the city there are many warm valleys where there are fruits and other trees which grow well. Most of the fruit is brought to the city for sale.

"They also reap much wheat of which they make bread; and they have planted many orange trees and other fruit trees both of Spain and of the country. They have mills over the stream which flows through the city, and at a distance of four leagues may be seen the quarry from which the stones were conveyed of which the city is built—a sight well worth seeing.

"They raise fowls in Cuzco and capons as fat and as good as those of Granada; and in the valleys there are herds of cattle and flocks both of Spanish sheep and those of the country.

"Although there are no trees round the city, the pulses of Spain ripen very well."

In brief, the climate of the most favored parts of the Sierras induced civilization. It was warm, yet healthful; it was varied and, therefore, yielded a variety of products and a consequently varied dietary. The temperature was equable, yet the rhythm of rainfall gave the necessary spur of the seasons. The crops were excellent, provided always that skill and constant labor were given to their care. Thus, climate bred coöperation and coöperation meant here, as it always has, wealth, a leisure class, and hence the arts.

In the less favored parts of the plateau, notably much of that part now known as Bolivia, the more rigorous climate meant a less productive soil, a smaller return from labor, and little opportunity for leisure. In consequence, the Indians of this region, although of the same stock, made slower advancement and even in their persons showed the unfavorable effect of the climate. They were, and are, stouter, thicker set, better tempered but duller, with features more irregular and coarser than those of their more fortunate kinsmen and neighbors.

It is the fashion nowadays to sneer at the ancient civilization of the Incas, a natural reaction from the belief on the part of many of the early Spanish historians that it was in the nature of a miracle—a sudden flowering from a brief vegetative period of development. Reading their history with the eyes of a man of science, knowing that the development of such a civilization must have been very slow, that long ages must have elapsed before the Quichua Indians could have become an imperial people, and above all, noting as one reads that each gradual advance had its roots in the climate of the country, then the narratives of Cieza and Garcillasso de la Vega, at any rate, become briefs in the hands of the historians who realize that geography makes history.

CLIMATIC BASIS OF THEIR RELIGION.

A man's, or a nation's, religion is the most important fact about him, or it, say the psychological historians. Doubtless this is true but one must not forget that even religion has its beginning in the physical environment of the people.

The Quichua Indians believed in a Creator, the god of the Sun, of the Thunder, and other nature gods, in the immortality of the soul and in the resurrection of the body.

Next to the Creator, they worshipped most the Sun and Thunder. Prayers were always offered to them at each of the periodic festivals. Molina quotes the following: "O Creator, and Sun, and Thunder, be forever young! Do not grow old! Let all things be at peace! Let the people multiply, and their food, and let all other things continue to increase. O Sun! Thou who art in peace and safety, shine upon us; keep us from sickness, and keep us in health and safety."

The middle of May was the beginning of their year. Then were celebrated the festivals of the Sun, sacrificing to it large numbers of sheep of all colors. In June, they were far too busy irrigating their fields to spend their time worshipping any gods. Theirs was not a fanatical, self-immolating desert religion. It was the very practical religion of a temperate well-watered clime. In July, their planting time, the priest of the Sun offered up sacrifices "praying the Sun to give warmth so that their food might be produced," and the priests of the Thunder begged their god to send down its waters and not the destructive hail.

In the desert the sun is an enemy. But in the Sierra, the contrary is true. He is the friend of the people—more, the father, a god.

"The Incas selected a spot for building a temple where they might sacrifice to the sun," wrote Garcillasso de la Vega, "persuading the people that it was the principal god whom they should worship, and to whom they should give thanks for the natural benefits that he conferred on them by his light and heat; for they saw that these properties of the sun caused their crops to grow and their flocks to multiply, and produced the other mercies that they received every day."

But the first rains brought sickness. For this reason, in August were celebrated the elaborate ceremonies of the *Situa* described both by de Molina and Garcillasso de la Vega.

"The priests of the sun proclaimed the feast. First, all strangers, all whose ears were broken, and all deformed persons, were sent out of the city. . . . Then the people, who were armed as if for war, went to the square of Cuzco, crying out: 'O sicknesses, disasters, misfortunes, and dangers, go forth from the land.'

"One hundred of the four hundred warriors assembled in the square faced the east; one hundred the west; one hundred, the north; and the remaining hundred the south. To them, the priest from the temple of the sun cried out, "Go forth all evils." Thereupon, each group of warriors ran in the direction toward which he faced, running swiftly until they each reached a river in which they bathed and washed their clothes and hands.

"Such was the ceremony for driving the sickness out of Cuzco. Their reason for bathing in these rivers was because they were rivers of great volume and were supposed to empty themselves into the sea, and to carry the evils with them. When the ceremony commenced in Cuzco, all the people great and small, came to their doors crying out, 'Let the evils be gone. How greatly desired has this festival been by us. O Creator of all things, permit us to reach another year, that we may see another feast like this.' They all danced, including the Inca, and in the morning twilight, they went to the rivers and fountains to bathe, saying that their maladies would come out of them. . . . "

The traveller in Cuzco, especially if he is compelled to reside in its only hotel, wishes every moment that these ancient regulations for cleaning up the people and the town were still in force. In the whole world there can be no place filthier. Only its marvellous climate now keeps it from being a pest hole.

The climatic rhythm of the Sierra, with its resultant plants forced them to believe in immortality. One cannot read far in the old chronicles without encountering such passages as these:

"The custom of these Indians in ordering magnificent and lofty tombs to be made, adorned with tiles and vaulted roofs, and in burying with the dead all of his goods, his wives, a great store of victuals, and no small quantity of chica [wine used by them], with their arms and ornaments leads us to believe that they had some knowledge of the immortality of the soul, and of there being more in man than his mortal body. Deceived by the devil, . . . he . . . gives them to understand that, after death, they will be brought to life in another place which is prepared for them, where they will eat and drink at their pleasure as they did before they died."

"At this time, the old Pachacuti Yupanqui died . . . and many old captains were buried with him, together with all his pages whom, it is said, he would require for his service in the other life. They made them drunk before they were put to death."

The climate which enabled them with some little certainty to reap what they sowed, led them also to believe in a system of rewards and punishments—a heaven and a hell.

"How and through what tradition the Incas received the doctrine of the resurrection of the body, which is an article of faith, I cannot tell, nor is it for a soldier like me to inquire. . . . I can affirm with truth that they hold that belief," says Cieza.

Without doubt the dry climate rendering the mummifying of dead bodies natural and easy, and the consequent presence in their midst of the actual bodies of their beloved kings contributed materially to this belief.

Garcillasso says: "I found in the building five bodies of the Kings Incas, three of men and two of women. . . . The bodies were so perfect that they wanted neither hair, eyebrows, nor eyelashes. . . . I confess my carelessness in not having examined the bodies more closely. I did not think of writing this history or I should have looked at them with more care and ascertained how they were embalmed. . . . For my part, I believe that the principal art in embalming was to take the bodies up near the snow line and keep them there until the flesh was perfectly dry and that, afterwards, they applied the bitumen mentioned by the good father, to fill up and supply the place of the flesh that had withered. Thus, the bodies were as complete in everything as if they had been alive and well, and wanting nothing but the power of speech. This explanation occurred to me from having observed that the hung beef of the Indians, used in all these cold regions, is simply made by hanging the meat in the air until it has lost all its moisture. . . . In this way, all the meat was treated in the time of the Incas, that was used as food for their armies."

CLIMATIC BASIS OF THEIR GOVERNMENT.

Their government, like their religion, was eminently practical. It may be described as an intelligent socialism, but it did not spring full-fledged from the brain of a Quichua man. Its roots were deep down in the geographical condition of the country. It was a plant of slow growth developed by the actual necessities of living. Therefore, it lived without propaganda and survived all except a bloody conquest by alien people. Indeed, Polo de Onogardo writes: " . . . After the Spaniards came, the Indians continued for a long time to till the land of the Inca, and to store up the harvests according to the old custom, and to burn a portion in sacrifice, believing that a time would come when they would have to give an account to the Inca."

The rhythm of rainfall gave to its people the well-known spur of the seasons. They were forced to be orderly, forehanded.

A part of each harvest was set aside for the King Inca; a second part of the priests Inca; and the third for the laborers themselves. But this was merely a tentative division as the following incident related by Garcillossa clearly shows: "In those days there was a great famine which lasted for seven years and during that time the seed produced no fruit. Many died of hunger and, it is even said, that some ate their own children. . . . They say that Amaru Tupac Inca during those seven years of famine, obtained large harvests from his farms. . . . That the dews always descended upon them at night, and that frost never visited them, insomuch that the people would have worshipped him by reason of the miracle; but Amaru Tupac would not consent to this insult to the Creator. He rather humbled himself—feeding the poor during the seven years of famine."

Not only was the grain in the royal and priestly storehouses distributed among the people in times of famine but, says the same authority: "In time of war the provisions were sent from some parts to others, in addition to the ordinary consumption, and there was such order in these arrangements, that no mistake ever occurred. Sometimes the stores were sent from the magazines in the mountains to the coast, at others from the coast to the interior, according to the exigencies of the case, and this was done with never failing speed and exactness. When there was no demand, the store remained in the magazines, and occasionally there was an accumulation sufficient for ten years."

When the people worked for the Inca or the sun, they ate and drank at the cost of the state or the church. The work was not performed by gangs nor were the men drafted into it. On the contrary, all of the people except the aged and sick went forth gaily to the fields, dressed in their best clothes and singing appropriate songs.

Where else except in a perfect climate could develop such ideals of labor?

Their attitude toward conservation is interesting. I quote again from the *Report* of the lawyer, Polo de Ondegardo: "The order established by the Inca in matters relating to the chase, was that none should hunt beyond the limits of his own province; and the object of this was that the game, while proper use was made of it, should be preserved. After the tribute of the Inca and of the religion had been paid, leave was given to supply the requirements of the people. Yet, the game multiplied by reason of the regulations for its conservation far more rapidly than it was taken, as is shown by the registers they kept, although the quantity required for the service of the Inca and religion was enormous. A regular account was kept of all the hunts, a thing which would be difficult for me to believe, if I had not seen it.

"The Inca made similar regulations with regard to the forests, in the districts where they were of any importance. They were assigned for the use of the regions where there was a lack of fuel. . . . It was ordained that they should be cut in due order and license, according to the requirements. It should, therefore, be understood that the pastures, the hunts, and the forests were used in common under fixed regulations; and the greatest benefit that your Majesty could confer on these Indians, next to their conversion, would be to confirm the same order established by the Incas, for to frame new rules would be an infinite labor."

Although the development of the Quichua had been slow, when once the period of conquest was initiated, their progress was very rapid. One good reason for this was that the very varied climate of the different parts of Peru gave them varied products. "Instead of being confined to the products of their native valley," writes Markham, "they now obtained gold from the mountains north of Titicaca; cacao from the Amazonian slope; more copper and silver from Aymdras; emeralds from Quito; fish from the Pacific; aji (pepper), cotton fabrics and improved systems of irrigation from the coast valley. They also added medical lore and a knowledge of vegetable dyes."

"Their colonies were wisely managed for they themselves understood the effects of climates. The order of the Inca was that, when Indians were thus transported from one province to another, . . . they should always be sent to a climate similar to that of their native land, that the change might do them no injury. It was, therefore, forbidden to send Indians of the Sierra to the Llanos because they would die in a few days," writes Garcillasso.

Cieza says: "As soon as a province was conquered, 12,000 men were ordered to go there with their wives, but these were always sent to a country where the climate resembled their own. If they were natives of a cold province, they were sent to a cold one; and if they came from a warm province, they went to a warm one. . . . In the Callao, and in all parts of Peru, where owing to the cold climate the land is not so fertile and abundant as in the warm valleys, they ordered that, as the great forests of the Andes bordered on these sterile tracts, a certain number of Indians with their wives should be taken from each village and stationed to cultivate the land in the places where the chiefs directed them to settle. Here they sowed the things which would not grow in their own country, sending the fruits of their labors to their chiefs. . . . Thus, although no maize can be raised throughout the Callao, the chief and people did not fail to obtain it by this arrangement, for the colonists brought up loads of maize, coca and fruits of all kinds, besides plenty of honey which abounds in all parts of the forests."

EFFECTS OF THE CLIMATE ON THE CHARACTER OF THE PEOPLE.

The deserts have given us dreamers and prophets. From the semi-arid lands with a temperate climate have come the practical men and hence the earliest civilization. Because neither the people of the coast nor of the Sierra had developed a written language, it is not possible to give biographies that will illustrate this fundamental difference in character, but it shows racially in all the remains that either people has left behind.

In comparison with the pottery of the people of the coast, that of the Incas while graceful and elegant, is more simple and more obviously adapted to the purpose for which it was intended. Their buildings are not gay with color but dull and sombre. Nevertheless, they exhibit marvels of skill and exactness in stone cutting. Even the roofs of straw at which it is now the fashion to laugh, were so well put together that no fire could consume them and those that survived the Conquest have endured to the present day. Markham examined one at Azangara which in "exquisite art and neatness of finish" rivalled the walls of solid stone.

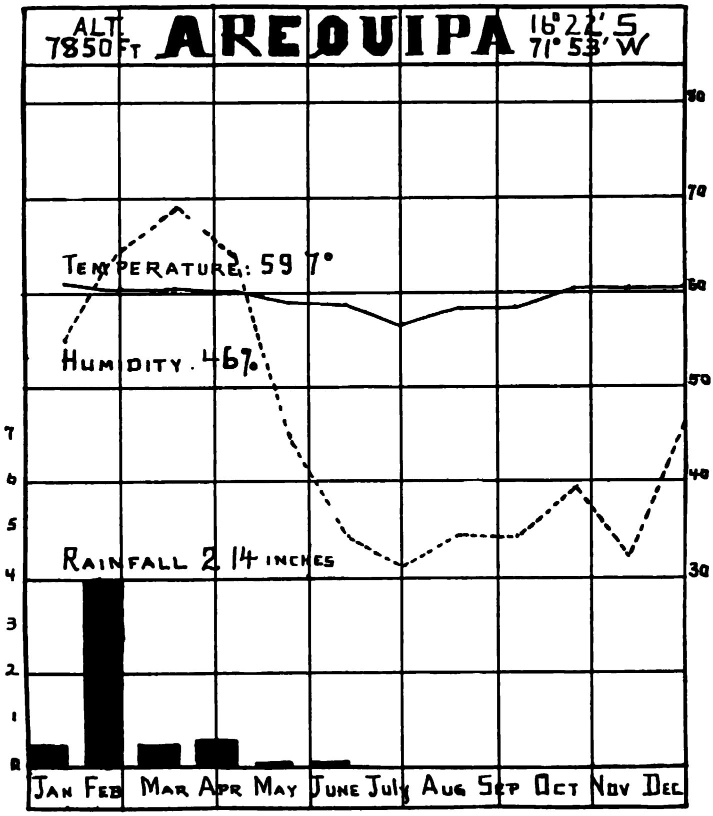
Their roads and irrigating canals were certainly superior to anything then existing in Europe. Of this one cannot doubt when he reads the enthusiastic accounts of them written by the young Cieza or in examining such irrigation canals as yet remain, or the yet undestroyed portion of the road to Quito.

Their knowledge, too, was eminently practical. "They beheld the effects, but did not seek out the causes." They had considerable knowledge of astronomy, the solstices and equinoxes, eclipses of the sun and moon. Some geometry they knew and used it in measuring land, settling boundaries, etc. There is a record of a model, to scale, of the city of Cuzco, "so well delineated that the best cosmographer in the world could not have done better."

THE MONTAÑA.

The word *Montaña* is invariably used in Peru and Ecuador to indicate the Amazonian slopes. In Peru it is a name with which to conjure. I was in Cuzco when a member of the legislature returned from an expedition to the Tampopata, an affluent of the Madre de Dios. The city was in a ferment until finally he gave them a lecture telling his experience and, thereafter during my stay, not a day passed that I did not see somewhere a group of people discussing eagerly the possibilities of a road following his itinerary. It transported me to Europe, to the Columbian and pre-Columbian centuries.

Just so must each seeker of new routes to India have been received by his townspeople then, for, to the intelligent Peruvian, the Montaña holds the wealth and charm and mystery of the ancient Orient.



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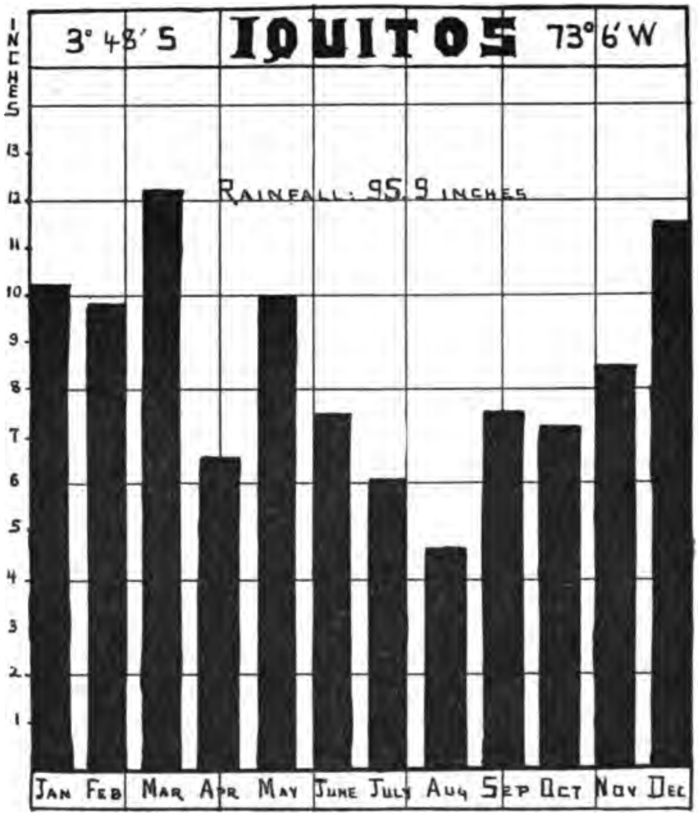
The Peruvian government is keenly alive to the possibilities of wealth in its Montaña. It has given lands freely for roads and for colonies. To the Inca Mining Company, which has now turned its attention to the exploitation of rubber, it has given 8,000 acres of land for each mile of road constructed between the San Domingo mine and a navigable point on the Tampopata; thence the route is continued by the steamer "Inca" to Riberalta, whence the San Antonio railroad will complete the connections *via* the Madeira and

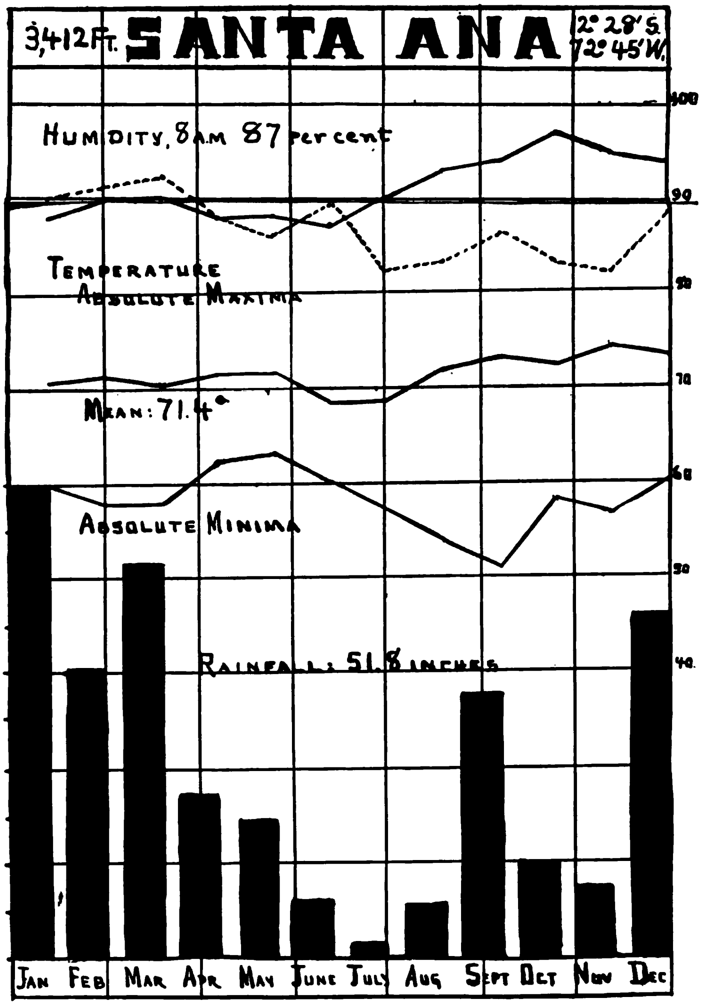
Amazon to the Atlantic. Some of the newly created villages on the road to the river are better equipped with telephone and telegraph stations than places of equal size in older civilizations.

CLIMATE.

The *Montaña* is in the belt of the southeast trades. The actual basin of the Amazon is hot, but the slopes above, ranging from 10,000 feet to 1,000 feet, because of their elevation, have a climate superior to that of the typical tropics. The ever-blowing cool wind also contributes materially to the comfort of the traveller; nevertheless, it is a region of constant rainfall; fogs and mists and mirages are frequent. Enoch observed here the wonderful anthelion.



The subjoined graphs give a picture of the climate of this region, yet I cannot refrain from quoting in this connection the data

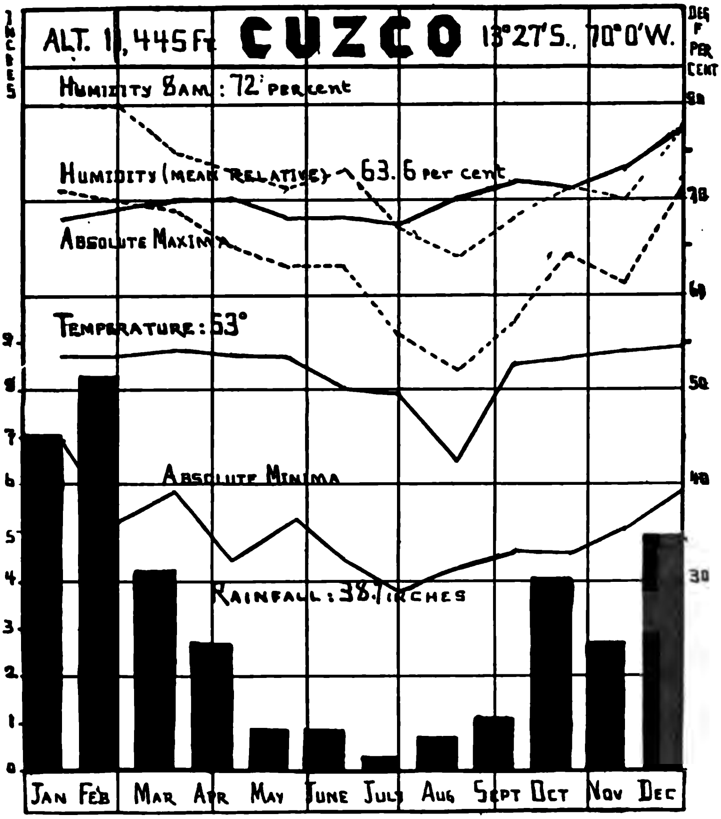


JULY 1894 – JULY 1895

for Tampopata furnished by Don Juan de la Cruz Gironda to Sir Clements R. Markham when he visited him during his quinine investigations:

"January—Incessant rain with damp heat day and night; sun never seen; fruits ripen.

"February—Incessant rain and very hot. Sun never seen. A coca harvest.



JULY 1894 -DEC 1895

"March—Less rain; hot days and nights; little sun. Bananas yield most during the rainy season.

"April—Less rain; hot, humid nights and little sun in the daytime.

"May—A showery month but little heavy rain. This is the month for planting coca and sugar-cane, and what is called the

Michca or small sowing of maize, as well as yucas, avacachas, camotes, and other edible roots. Coffee harvest begins.

"June—A dry hot month; much sun and little rain. Coca harvest early in the month. Oranges and paccays ripen. Cool nights but a fierce heat during the day.

"July—The hottest and driest month but with cool nights. Very few showers. Time for sowing gourds, pumpkins and watermelons.

"August—Generally dry. Trees begin to bud. A month for planting.

"September—Rains begin. Time for blossoming of many trees. Coca harvest.

"October—Rains increasing. Maize harvest and time for the *sembra grande,* or great sowing of maize.

"November—Heavy rains. A coca harvest.

"December—Heavy rains. Pumpkins ripen."

EFFECTS OF THE CLIMATE ON VEGETATION.

The banding of the vegetation caused by the different climates of the Montaña is striking even in so short a descent as that from Aroya to the Rio Perené. One sees the Sierras glistening with snow, then the vegetation, essentially temperate, of the Andean foot-hills with open grassy valleys and plains, and at last tropical virgin forests.

What heat and constant rainfall can do for plant life is splendidly shown in the following quotations from Markham's "Travels in Peru":

"In many places it was almost dark at midday, while in others the rays of the sun succeeded in forcing their way through the ferns and throwing a pale light across the otherwise gloomy passage. It was a weird unearthly scene. . . . Between lordly trees of great height, the ground was entirely choked up with creepers, fallen masses of tangled bamboo, and long tendrils which twisted around our ankles and tripped us up at every step. Ten miles on open ground is only equal to one over such a country as this. . . . This had been a most fatiguing march. In some places we were a quarter of an hour forcing and cutting our way through a space of twenty yards and the halt was most welcome. . . .

"The magnitude and variety of the trees of the forest was very striking; and the imposing character of the scenery in these solitudes was a source of constant enjoyment and lightened the fatigue of the journey. Among the wonders of the forest, there were enormous trees with great buttressed trunks; others sending down rope-like tendrils from the branches in every direction; the gigantic balsam tree, the India rubber tree and many others. A list of the ferns or mosses, endless in their variety and size, would fill volumes. Of palms also, there are many kinds . . . and many beautiful orchids in the branches of the trees."

EFFECT OF THE CLIMATE ON THE PEOPLE.

The reason why the Montaña in spite of the great possibilities of wealth that it offers to those who seek here is even yet undeveloped, is well shown in a single sentence from Markham:

"Late in the evening, I returned to the tent dead-tired, sodden and wet to the skin, covered with moss and fungus, bitten all over by mosquitoes, stung by a hornet, and with hands sliced in pieces by the sharp blades of a *Panicun,* called Challi Challi, but with only three plants of the valuable variety—*Chinchona ovata.*"

The basin of the Congo teems with human life; the basin of the Amazon has always been scantily populated. Why? Because the elevation of the Congo basin gives to it a very different climate from that of its tropical sister river. But there is no climatic reason why the higher slopes of the Andes with their unlimited agricultural possibilities should not support not only a large population but also a white people. Several colonies have been organized. In 1858 some Germans established themselves on the river Porzuzu at an altitude of 5,000 feet but they have steadily decreased in number. Later a British colony settled at Chanchamayo to grow coffee, attracted there by the suitability of the soil and the slope of the land for that kind of agriculture as well as by the generosity of the land grants. The difficulty, however, is not in growing the product, it is in the marketing. Until there are good roads, or until canals and railroads make the Amazonian waters more available for trade, there will be no considerable migration to this region of perfect climate.

In the lower parts of the Montaña, the problem is more nearly climatic. Even the wild products are worth while, and the question of transportation is far less difficult. It is the climate and its invariable consequents—malaria and anæmia—that render the region almost uninhabitable to the Indians as well as to the whites. The final conquest of the tropics, the final triumph of man over climate, promises to be the gift of the twentieth century to mankind. But at the present time, while the Montaña occupies two thirds of the area of Peru, only a twelfth of her population is located there. This twelfth of the population consists of wild Indians. It is interesting to note that whenever any one of the hundred and twelve tribes is credited with any virtues by travellers, it almost invariably turns out that somewhere in the race is an admixture of either Spanish or Quichua blood. For example, the Jeveros, described by Markham and others as the best of all, in 1599 captured some Spanish women. The Mayorunas, brave though ferocious, are believed to possess the blood of Spanish soldiers. The Antis, the Setebos, and the Shipibos, are supposed to be able to reckon the Incas among their ancestors. They are not only friendly to the whites but are straightforward in their dealings. The same thing is true of the Campus who actually cultivate large plantations of corn, bananas, etc. Most of these tribes have not only an admixture of the blood of people of temperate lands, but they inhabit the higher reaches of the Montaña.

Probably no better example of the unadulterated effects of humid, hot climate on people can be given than that of the Inji-Inji Indians. They are so called because these two syllables constitute their entire language. By speaking them with different accents, these syllables are made to express different things. The tribe is very small, a few hundred occupying some of the ravines of the Curaray. They have not only practically no language, but also very little skill. Their chief accomplishment is the girdling of trees.

The arts not only of the Inji-Inji Indians, but also of all the other tribes are, as might be expected, very primitive. One of them, however, deserves mention, not only because it is unique but also because it probably owes its development to the humidity of the air. Moist air carries sound much better than dry. This perhaps accounts for the really remarkable development of the art of signaling, practiced by the Aguarunas of the Marañon region, described by Señor Muro in the *Journal of the Geographical Society of Lima.* He relates that on one occasion, some two hours before his arrival, he heard a sound in the forest. This was repeated from hut to hut. When finally he arrived, there were some two hundred Indians awaiting him. They had been told of his coming by a sort of telegraphic code communicated to them by blows struck upon the tunduy. The tunduy is a hollow tree trunk about six feet long by a foot and a half in diameter. It has five holes of varying size. It is suspended by a cord from above and fastened to a stake below to keep it motionless. When struck with a club, a sound is made which travels far.

On another occasion, Señor Muro listened to a conversation carried on between two Indians whose huts were at least fifteen hundred feet apart, with the Marañon between.

In this connection, it is interesting to remember that wireless telegraphy, a failure in the Congo and also in Brazil, is now successfully carried on in the very heart of the Montaña. The stations are at Port Bermudez and Massisea, both on the Ucayali.

. . . .

The fairy godmothers were all of them present at Peru's christening. The greatest gift of all was that of her varied and perfect climate. Chile took from her her nitrates; she herself wasted her guano; the North Americans—as they call us—are profiting by her mineral stores; and, at the best, some time they too must come to an end. But in her climate she possesses a Fortunatus' purse. Coast and Sierra and Montaña—to name their products actual and possible, is to exhaust the agricultural and horticultural lists of the world.

Best of all, the Peruvians are beginning to realize how precious yet inexhaustible are these gifts of climate and have already begun to exploit them.

SHORELINE CHANGES IN THE WINTHROP AREA, MASSACHUSETTS.

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The Winthrop Area.—The area of investigation covered by this paper lies five miles east and northeast of the city of Boston and extends from Deer Island northward through Winthrop and Revere Beaches to Point of Pines and Lynn Harbor (Fig. 1). The southern half of the area forms the southern and eastern boundary of the harbor of Boston and is largely the harbor's protection from the direct sweep of the Atlantic waves. The region consists for the most part of typical oval drumlins with their axes extending in a northwest-southeast direction, connected along the ocean side by beaches but otherwise separated from each other and from the mainland by tidal marshes and arms of the sea. A large sandplain at Winthrop village is an important exception to this general drumlin topography. On the ocean side the drumlins have been extensively eroded by wave action, and present high steep cliffs, at the foot of which are masses of boulders constituting the coarser débris from the destroyed portion of the drumlins. At several points off-shore similar groups of boulders are exposed at low tide and these are connected to the islands and beaches by bars. At other points similar bars extend, finger-like, from the shore to deeper water and end in shoal areas. The hills west of the shore line are at present being but slightly cliffed by the waves of the harbor and marshes, and there is no evidence of former extensive wave cliffing, either at higher or lower levels, on any of the drumlins or sand plains.

This paper discusses the changes which have occurred in the shoreline of the Winthrop region, and the rate at which these changes have taken place. A detailed description of the area will first be

Note.—This article was prepared in part fulfillment of the requirements of a graduate course in physiography at Harvard University, under the direction of Professor D. W. Johnson, to whom the author is greatly indebted for many suggestions.

given, followed by an account of changes now taking place, or that have taken place in recent times, both in shore outline and in variations of sea level, as shown by a study of old surveys and maps, and by historic records. From these data the rate of present recession of the cliffs is computed and an estimate made of the time required for the destruction of some of the drumlins.

Description of the Winthrop Area—Deer Island.—This island (D.I.) Fig. 1, at the southern end of the area contains, in whole or in part, five drumlins—Signal Hill (S.), two small drumlins, one on either side of Signal Hill, and the parts of two large drumlins, one at North Head (N.) and the other at South Head (S.H.). The eastern tip of Signal Hill has been slightly cut by the waves. North Head is a steep bluff, over 70 feet high, cut in boulder clay. Its contour lines indicate that the present bluff is but a part of the southwestern side of a large drumlin. South Head is a low mound cliffed on all but its northern side. The uncliffed side, sloping upwards towards the sea, indicates that this bluff is but the mere remnant of a large drumlin. South Head is joined to Signal Hill by two beaches, the one on the east, a high, straight shingle beach, we will designate Little Faun Beach and a low sandy beach on the west. From Signal Hill to North Head is a third beach, Great Faun, and to the north from North Head extends a plain of sands and gravels formed by the growing spits which terminate at Shirley Gut (S.G.), the channel separating Deer Island from the area to the north.

At the foot of the cliffs and extending seaward to what were probably the outer margins of the destroyed drumlins, are masses of boulders exposed at low tide. A short distance east of both Little Faun Beach and Great Faun Beach are similar masses of boulders (L.F. and G.F.) not associated with any drumlins now in existence. From both these masses low triangular sand bars, exposed to view at low tide, extend back to the beaches. Still farther east on Great Faun Bar, at the Beacon (B.), is another area of small boulders and gravels. Both Little Faun and Great Faun bars extend eastward for more than a mile and terminate in each case in wider and shallower areas, beneath low tide level. At Deer Island Light (D. L.) is a rocky shoal similar to that at Great Faun Beacon. All the cliffs on Deer Island are now protected by sea walls, so that further destruction has been arrested.

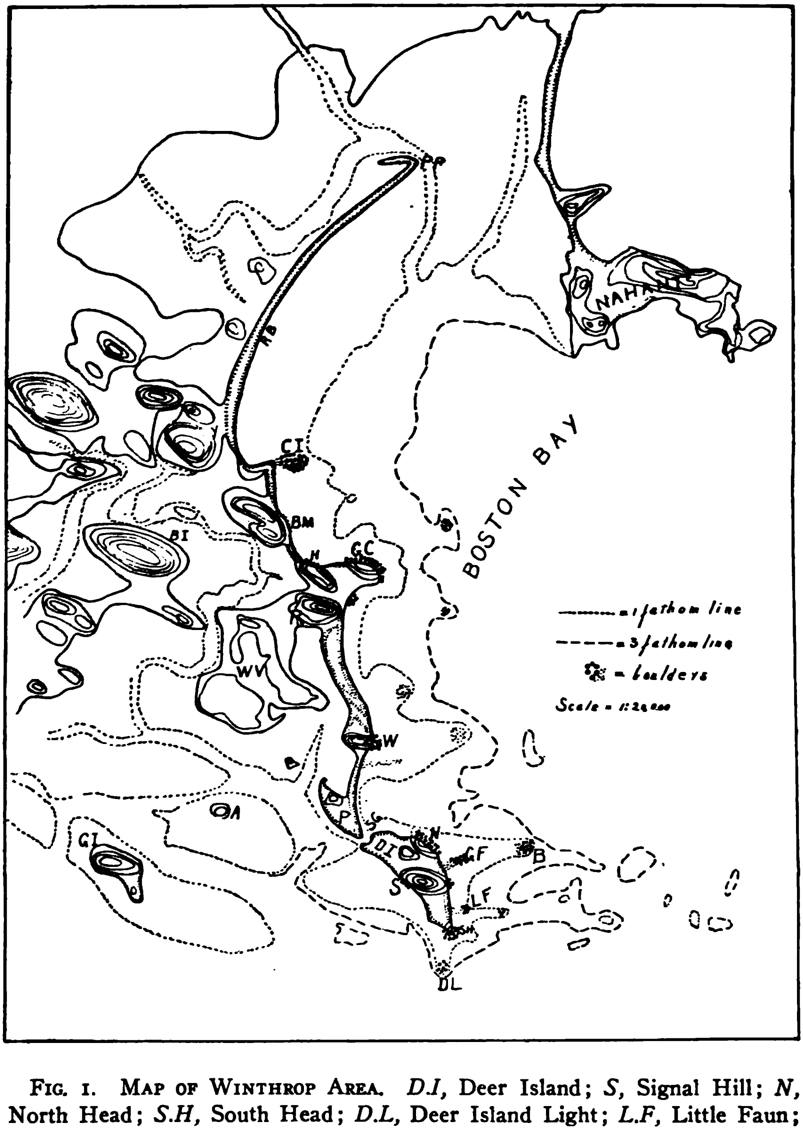

FIG. 1. MAP OF WINTHROP AREA. *D.I,* Deer Island; *S,* Signal Hill; *N,* North Head; *S.H,* South Head; *D.L,* Deer Island Light; *L.F,* Little Faun; *G.F,* Great Faun; *B,* Beacon; *P,* Point Shirley; *S.G,* Shirley Gut; *W,* Winthrop Head; *R,* Residence Hill; *G.C,* Grover's Cliff; *Bm,* Beachmont; *C.I,* Cherry Island Bar; *R.B,* Revere Beach; *P.P,* Point of Pines; *B.I,* Breed's Island; *W.V,* Winthrop Village; *G.I,* Governor's Island.

Point Shirley, north of Shirley Gut, is made up of a small drumlin, Point Shirley Hill (P.), and a plain of sand and gravel formed by beaches and spits which nearly surround it. Point Shirley is connected to Winthrop Head by a high, wide beach of sand, gravel and small boulders, which has been built up in front of Point Shirly Hill, thus protecting it from destruction.

Winthrop Head.—Nearly one-half of this drumlin (W.) has been eroded by the waves, the remaining half terminating in a cliff over 100 feet in height. A platform covered with boulders indicates the former extension of the drumlin, while farther east extend bars similar to those at Great Faun and Little Faun.

Winthrop Beach.—The great amount of building and street grading at Winthrop Beach have made detailed structure difficult to decipher. Two distinct beaches, however, can be traced. The present eastern one extends in a double, or S-shaped, curve from Winthrop Head (W.) to Residence Hill (R.), convex toward the ocean at its southern half and concave at the northern half. To the west of this East Winthrop Beach is a second beach, concave throughout its length, sharply curved at its northern extremity where it ends against the east beach by which it appears to have been cut off. In the thickly built-up section near Winthrop Head it is impossible to determine its exact southern termination. It seems, however, to merge into the East Beach close to the hill. This second beach we will call West Winthrop Beach. It is best seen in its central portion, but buildings and gradings often obscure it in other sections. It is somewhat lower than the present east beach. Further complexity is added to the topography by the presence of low sand ridges running diagonally between the two beaches from the convex part of the east beach northwestwardly to West Beach.

Grover's Cliff.—A continuous cliff extends from the northern end of Winthrop Beach around the projecting headland called Grover's Cliff (G.C.). This bluff reaches a maximum height of 70 feet on its northern side and in places rises nearly perpendicularly from its base. Figs. 2 and 3 show the nature of the cliffing and the boulders at the base of the cliff at the eastern end of Grover's Cliff. These illustrations are typical of the cliffing on the other drumlins. Grover's Cliff is almost identical in form with North Head on Deer Island and, like it, is developed on the northwestern remnant of a large drumlin. Two bars extend northeast and southeast from the cliff terminating in shallows, the northern one of which is marked "rocky" on the U. S. Coast Survey Chart. A short beach connects Grover's Cliff to Winthrop Highlands (H.). Winthrop Highlands and Beachmont (Bm.) are but slightly cliffed, and are connected by a high sand beach.

Cherry Island Bar and Ocean Pier.—A high beach of coarse materials extends north from Beachmont to Ocean Pier. Here it turns sharply to the southwest making a sharp angle at the Pier, and, bending again northward at Crescent Beach, is continued as Revere Beach (R.B.), changing, however, to fine sand at Crescent Beach. East of Ocean Pier, covering an area 1,200 feet in length, is another mass of large and small boulders known as Cherry Island Bar (C.I.). Underneath these boulders at the time of the building of the Pier, excavation showed the presence of boulder clay, confirming the conclusion that the boulders are but the superficial covering of the base of a truncated drumlin. Revere Beach extends northward for nearly three miles to Point of Pines (P.P.) at the mouth of Saugus River.

Region West of the Shore Line.—Back of the line of cliffs and beaches forming the shore line are wide tidal marshes at the northern part and open water at the south, above which rise many drumlins—Oak Island, Young's Hill (Y.), Breed's Island (B.I.), Apple Island (A.), Governor's Island (G.I.), and several others. The extensive highlands on which the main part of the village of Winthrop (W.V.) is situated is made up, for the most part, of stratified sands and gravels, forming a sand plain gently sloping to the east and north. Stratified sands and gravels also abut against Residence Hill (R.), on its western and southern sides. These two sand areas are about 40 feet above sea level. A similar, but lower, stratified gravel area lies to the southeast of Breed's Hill. The ridge along the northern side of Winthrop village is a drumlin.

Wave action is effective on the harbor side of the Winthrop area, producing cliffs at the western ends of Signal Hill and Winthrop Head drumlins, along the southern edge of the Winthrop sandplain and about the islands of the harbor. The bases of the drumlins in the marshes are being slightly cliffed wherever they are reached by the tidal estuaries or by waters overflowing the marshes at high tide. But there is no evidence that the sea has ever worked

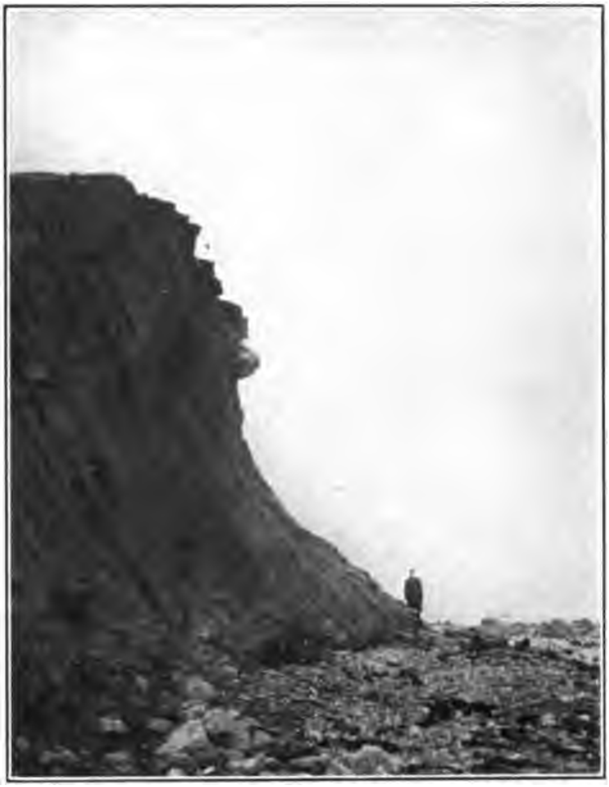

FIG. 2. GROVER'S CLIFF, NEAR EASTERN END.

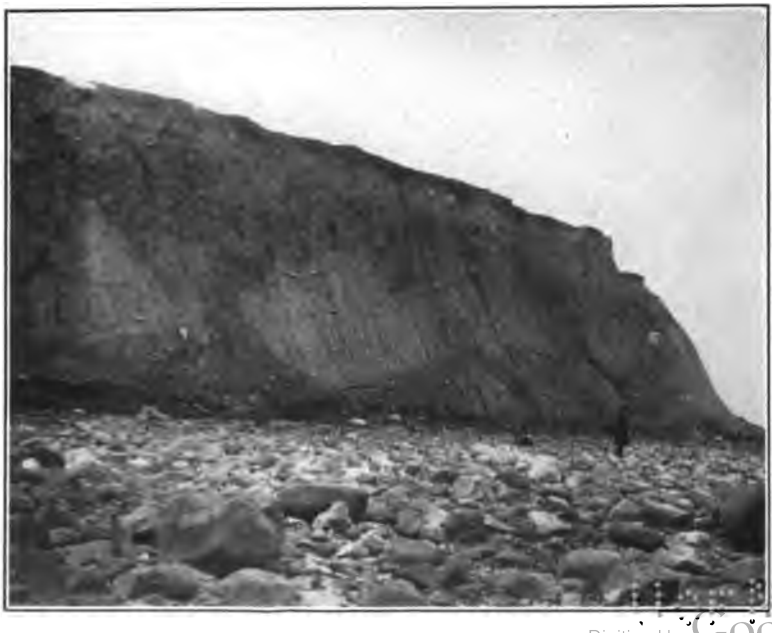

FIG. 3. BOULDERS AND CLIFF, GROVER'S CLIFF.

more effectively in this region than now; no abandoned cliffs are found where the marshes abut the drumlins, such as might indicate a more vigorous wave attack before the inter-drumlin beaches and the marshes were developed.

Recent Changes in Shore Line—Recession of Headlines.—A casual examination is sufficient to show the relatively rapid recession of drumlins where exposed to wave attack. The heavy masonry walls at the base of the cliffs from South Head to Beachmont—either now built or in course of construction—show man's attempt to hold back the hungry sea. But these bulkwards are often insufficient. At Winthrop Highlands much of the wall has been worn away and the roadway at the base destroyed by the waves. The bare cliff of Winthrop Head and the great masses of till that are repeatedly slipping down its steep slope tell of the rapid rate at which it is being cut back. The first railroad to Winthrop passed along the base of this cliff, but its repeated destruction by the waves made its early abandonment imperative, and to-day scarcely a vestige of the old roadbed has been left by the waves.

A comparison of the surveys of 1860 and 1908 at Winthrop Head shows that the cliff has receded about 36 feet in 48 years, or at the rate of 9 inches per year. This rate has been verified by surveys during intermediate periods by Whitman and Howard, civil engineers, of Boston, who allowed the writer to consult their maps of the region.

At Grover's Cliff, records and maps have been compiled by the U. S. Army Engineer, the surveys covering two periods: from 1891 to 1898 and from October, 1903, to August, 1905. From these maps the following computations have been made covering a distance of 1,100 feet along the eastern end of the cliff.

From 1891 to 1898.

	Feet.
1. Average recession along 1,000 feet of cliff................	5.03
2. Average rate per year 1,000 feet of cliff....................	.75+
3. Average recession along 300 feet of cliff where recession was most rapid	14.03
4. Average rate per year where recession was most rapid (3)..	2.00+
5. Maximum recession at any one point......................	25.00
6. Maximum yearly rate of recession at any one point........	3.05

From October, 1903, to August, 1905:

1. Average recession of 1,100 feet of cliff	2.02
2. Rate of recession per year	1.01+
3. Average recession along 225 feet where recession was most rapid	7.00
4. Rate of recession per year where most rapid	3.05
5. Maximum recession at any one point	10.00
6. Maximum rate of recession	5.00
Yearly rate of recession along 1,100 feet of cliff for the nine years observed	.83

It will be observed that the two-year period shows a faster rate than the longer period, but that the longer period has a rate exactly corresponding to the rate of recession at Winthrop Head, *i.e.*, 9 inches per year.

The above figures are for the upper edge of the cliff. The recession at the foot during the 1903–1905 period was somewhat less rapid, as might be expected since large masses when undermined might slip down the cliff, advancing its base, while the top would show considerable retreat. Until the sea had removed this new material, the base of the cliff would temporarily be retarded in its recession. At some places, however, the base receded more rapidly than the edge, so that the variation in recession between top and base is not great. The rate of 9 inches per year may fairly be taken as the rate of recession of the cliffs along the coast line under discussion, since all are about equally exposed to the sea and off-shore conditions are essentially the same.

Recession of Beaches.—All the evidence available indicates that Crescent Beach, west of C.I., is retreating. A shore wall has been built at the point of greatest curvature to prevent the advance of the sea, and the old inhabitants say that more marsh area existed west of Cherry Island Bar in the past. It has been reported that peat has been exposed on the ocean side, under the present beach. This would unquestionably indicate a retreat of the beach over the marsh, but the author has been unable to verify the report.

The northern end of Point Shirley Beach, just south of Winthrop Head, as shown by surveys of Whitman and Howard, has retreated 120 feet since 1860, while the southern end has changed but little. During the movement the width of the beach has remained nearly the same. The rate of retreat of the northern end is 2.5 feet per year—much more rapid than the retreat of the adjacent cliff.

No data is at hand to show the changes taking place just north of Winthrop Head. That important changes have occurred here in the past is proved by the presence of West Winthrop Beach and the cross bars described on page 49.

Figure 4 shows a possible explanation of the present Winthrop Beach. The continuous line (1) represents West Winthrop Beach, formed when both Grover's Cliff and Winthrop Head were much further to the east, the deep curved beach being characteristic of a young beach formed between projecting headlands. As Winthrop Head retreated, the extreme southern end of West Beach was necessarily pushed back but in the central portion there was a tendency for the beach to advance as littoral currents were deflected more and more to a direction parallel to the shore. The tendency for beaches to straighten as headlands recede is characteristic of beach development (Davis, *b*; Gulliver). Thus the various ridges 2, 3 and 4 (Fig. 4) represent successive attempts of the beach at advancement. Finally the stage was reached where waves and currents completed a new beach between the headlands (5, Fig. 4) in front of the old beach, producing Winthrop Beach as it now appears and giving it the S-shaped curve, convex in the southern half, concave at the northern. According to this explanation, the beach at the section marked A should continue to advance, gradually straightening out the line of Winthrop Beach as the cliff retreats at Winthrop Head. No data, however, is available to show if this is actually the case.

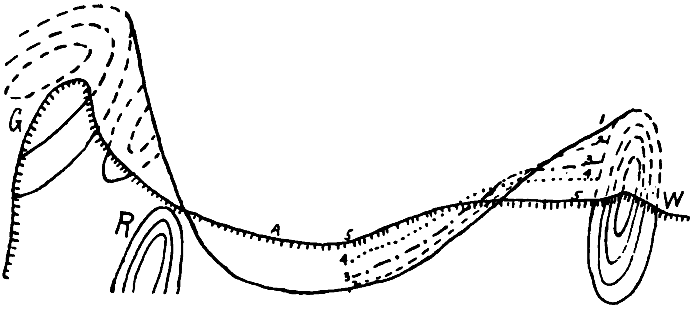

FIG. 4. DIAGRAM SHOWING FORMATION OF WINTHROP BEACH. *G*, Grover's Cliff; *R*, Residence Hill; *W*, Winthrop Head; 1, West beach; 2, 3, 4, Cross-bars; 5, present shore line. Dotted contours represent destroyed portions of drumlins.

Growth of Spits.—In his "journal" for September 22, 1632, Governor Winthrop states, "The Barnstable ship went out at Pullen Poynt to Marbleharbour." Pullen Poynt is the old name for Point Shirley. From other sources it is known that Shirley Gut was long used in Colonial times as an exit for ocean going ships. But, allowing for the small size of trans-Atlantic vessels of those days, the good ship Barnstable would to-day find much difficulty in passing through this channel, if indeed it were at all possible. The first large chart of Boston Harbor was made from surveys by Samuel Holland, Surveyor General of Lands and published by Des Barres in London in 1775. This map, 42 × 30 inches, gives not only the topography of the land, but locates the shoals and gives soundings of the channels and is unquestionably accurate in its larger features at least. Shirley Gut on this map is over 1,000 feet in width and 30 feet deep. In 1860 the channel had narrowed to a width of 460 feet at mean high water and 240 feet at low water, less than half the width of 1775. In 1898, 38 years after, these widths had again been cut in half, 280 feet at high water and only 95 feet at low water, while the depth at the narrowest point had been reduced to 10 feet. During recent years repeated dredging has been necessary to keep the channel open for the use of the small craft which have used the passage. A strong current rushes through with the rise and fall of the tides and Shirley Gut has often been referred to as a channel kept open by tidal scour. The facts, however, show exactly the opposite condition. The spits on opposite sides of the channel are approaching each other while the channel itself is being filled, thus gradually welding Deer Island to the chain of drumlins to the north. The diagram, Fig. 5, shows how these spits have changed between 1860 and 1898.

Destruction of Drumlins—Cherry Island and Nix's Mate.—Tradition has it that an island once stood where now is Cherry Island Bar (see page 50). On this island was an orchard of cherry trees, whence the name "Cherry Island," and this almost within the memory of men now living.

Nix's Mate lies about a mile south of Deer Island and is here described since it is an interesting illustration of the final destruction of a drumlin, verified by historic records. In colonial days it was an island of considerable size and was long used as a place for pasturage of sheep. In the Massachusetts Colony Records for September 8, 1636, occurs this entry, "There is 12 acres of land granted to John Galop upon Nixes Island to enjoy to him and to his heirs forever." John Galop's heirs to-day would find standing room on "Nixes Island" only at low tide and then upon a heap of gravel or boulders. In later colonial days the island was a place of burial of executed pirates. The *Boston News Letter,* July 14, 1726, records the execution of three pirates and states that "their bodies were carried in a boat to a small Island called Nick's Mate, about 2 leagues from the town, where Fly (one of the pirates) was hung up in Irons as a Spectacle for the Warning of others, especially sea-faring men; the other Two were buried there."

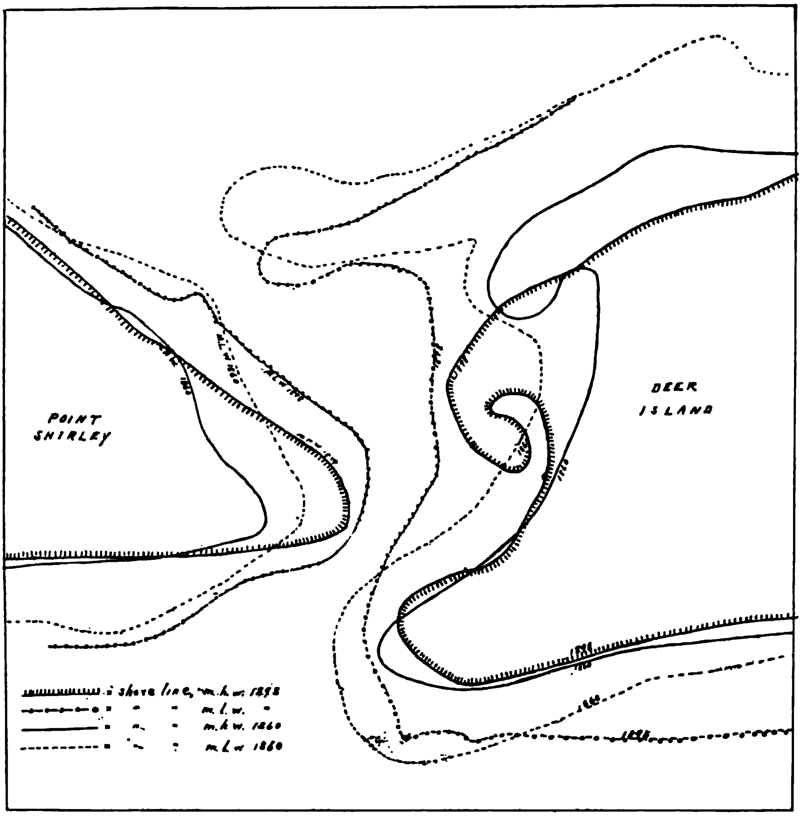

FIG. 5. SHIRLEY GUT, 1860 AND 1898.

The north end of this former island was a low bluff known as

North End Point and as late as the Des Barres Map of 1775 a considerable elevation was indicated. The bar which trailed in the rear of the old headland on Des Barres map is to-day a long bar trailing back from the remaining boulders. The resemblance of Nix's Mate to Cherry Island Bar, Great Faun and Little Faun is very close—all are heaps of boulders with sand bars trailing back from them. That all mark the site of drumlins destroyed by the waves seems conclusive.

We have thus in the Winthrop area drumlins in all stages of destruction—from the uncliffed Breed's Island through the various stages of cliffing at Signal Hill, Winthrop Head, North Head, and South Head, to Cherry Island Bar, Great Faun, and Great Faun Beacon where only the boulders remain and these shoals in various stages of destruction. Finally those numerous sea bottom elevations, some of them known to be rocky, connected by long trailing bars to the coast appear to be the last stage in this process of destruction.

The Shore Line has Receded to its Present Position.—From the preceding discussion of changes it is evident that the waves have cut back not only the drumlins represented by the present cliffs, but many others whose truncated bases are now at or below sea level and which are represented by the shoal areas terminating the bars. The vast amount of beach and bar materials in the Winthrop Area further bears out this conclusion, for it is clear that the material eroded from the present cliffed drumlins would be far from sufficient to construct the large beaches and sand bars so numerous here. Other sources of building materials are necessary. Detritus brought by the rivers, or by the waves from the ocean bottom, may have supplied some of it, but the chief source has probably been from the destroyed drumlins of the bay.

Furthermore, if the present rate of recession has been maintained in the past, it follows that the shore line was in comparatively recent times much farther to the east. If we assume that the destroyed part of Winthrop Head was a symmetrical continuation of the present remnant, about three-eighths of the drumlin has gone, or about 800 feet. At the rate of 9 inches recession per year, it has required 1,066 years to bring the cliff to its present position, assuming that the rate has been uniform. Now, the minimum estimate of post glacial time is 5,000 years, and therefore it has been at least

5,000 years since the ice, retreating, left the drumlin of Boston Bay exposed to the waves. This length of time, still assuming the present rate of cliffing, would allow for nearly five times the amount of recession observed at Winthrop Head, or 3,750 feet. Has the rate of recession in the past been the same as at present, or slower, or faster? This can be answered only after examining the factors entering into the rate of recession of sea cliffs.

Factors Affecting the Rate of Recession of Cliffs.—The rate of recession of a sea cliff will depend upon five factors: (1) The force of the waves, (2) the character of the material in the cliff, (3) the height of the cliff, (4) the rate of disposal of the eroded material, (5) elevation or subsidence.

1. It is self evident that, other things being equal, headlands exposed to strong wave attack will suffer greater erosion than those exposed to the action of small and weak waves.

2. It is likewise clear that the rate of recession depends in part upon the resistance of the material being eroded. The rocky headlands at Nahant, for example, receded very slowly as compared with the less resistant till of the harbor drumlins.

3. High cliffs will recede less rapidly than low ones; for the former give the waves a greater amount of work to do. The higher the cliff the greater the volume of eroded and weathered detritus which accumulates at the cliff base, and which must be disposed of. So long as the sea can dispose of this material quickly, the height of the cliff will not greatly affect the rate of recession.

4. If the material eroded from a cliff remains at its foot, the power of the waves is expended before reaching the cliff. If deep water off shore, or strong littoral currents, dispose of the detritus, the waves will continue to attack the cliff, although with diminished force as the breadth of the wave-cut bench (which must be traversed before the waves reach the cliffs) increases. On the other hand beach material may drift in front of headlands and protect them from the waves. Thus Shirley Hill is protected from further wave erosion on all sides by sand beaches.

5. If the coast is rising the amount of work required of the waves is continually increased by the rising of submarine areas into the zone of wave action; and, in some cases, the effectiveness of wave attack is diminished by a shallowing of the water off shore.

Hence cliff recession is less rapid, and the shore line may even advance. If the coast is sinking the zone of wave action will advance on the land, and the effectiveness of wave attack may be increased by the continually increasing depth of water on the wave-cut bench. Hence the rate of cliff recession will be relatively rapid.

Let these principles now be applied to the rate of cliff recession in the Winthrop area. In the first place the degree of exposure of the easternmost drumlins to the ocean has remained practically unchanged from past time; but the off-shore areas have probably become shallower as the shore line has retreated, leaving as shallows the bases of the eroded drumlins and formerly deeper areas now filled with the products of erosion. Thus the power of the waves has probably been lessened. The second factor has remained essentially constant, since the character of the till in the harbor drumlins is everywhere fairly uniform. The third factor, height of the cliff, would vary with the size of the drumlin and the stage of its destruction, the cliff being higher at the center of the drumlin and lower when at either end. Grover's Cliff and Winthrop Head, from which our rate of recession has been established, are sections nearly through the centers of drumlins that may be considered the average size of those at present in the harbor and presumably of those destroyed. Cliff height, in the two places considered, is therefore now at a maximum, and the rate of recession, so far as affected by cliff height, is at a minimum. The average cliff height in the past has been possibly about one half that at present, and the average rate of cliff recession has been therefore more rapid than at present.

The varying rate of disposal of eroded material has undoubtedly largely affected the rate of cliff recession. During the early stages of development, before shallow marine benches had been cut, and the deeper water had been shallowed by deposition, the removal of débris was much more rapid than now. The average rate of recession must have been much more rapid then, and must have been more nearly the same for high and low cliffs.

It may be urged that the formation of beaches in front of cliffs, thus arresting their recession for long periods of time (as has happened at Point Shirly Hill), makes any calculations based on a supposed average rate of recession in the past exceedingly uncertain. For example, the time computed above for the recession of Winthrop Head to its present position may be too small if cliffing here has at any time been arrested. This objection has less weight than might at first appear. In the first place, such arresting of cliffing will not ordinarily occur in the earlier stages of shoreline development, before a large amount of beach material has accumulated. Even now, beach protection in the Winthrop area is the rare exception rather than a common occurrence. Such protection, furthermore, develops only in front of cliffs that are back of the general line of the shore, and which were, in a sense, partially cliffed before their proper time, and later protected until the main line of wave attack should reach them. The rate of recession of the general shore line is determined by the rate of recession of the well exposed headlands, and is not affected by the temporary protection of poorly exposed cliffs. The beaches themselves offer very little resistance to wave attack when located on a retreating shoreline. Even single storms have been known to transport such beaches long distances. W. H. Wheeler (page 17) records the case of a shingle bank near Hursh Castle, England, two miles long and twelve feet high which was moved 40 yards during a single storm in 1824; and at Westward Ho a similar beach two miles long was moved shoreward 30 feet during a period of heavy storms.

The fifth factor upon which the rate of cliff recession depends (change of level) has probably had little effect for a long period, as will later be shown (page 60). However there is evidence of slight recent subsidence, which would tend to accelerate the rate of cliffing.

Thus of the five factors affecting the rate of cliff recession one may be considered as having remained constant since cliffing began—the resistance to erosion offered by the material in the cliffs. One, subsidence, may be at present slightly accelerating the rate. Three tend to give a slower rate now than in the past—the diminished force of the waves, the great height of the cliffs and, perhaps most important of all, the diminished rate at which the products of erosion are removed. Thus it follows that whatever may be the present rate of recession (computed to be .75 foot per year) it is very likely less than the average rate since recession began; and that the time computed for the recession of Winthrop Head (1,066 years) is too long rather than too short. An average recession of one and one half feet per year is possibly nearer the truth, in which case the cutting back of Winthrop Head drumlin has required something like 533 years, and, on an estimate of but 5,000 years for post-glacial time, the shoreline may easily have retreated 7,500 feet. But even if we should take the present rate of recession at half of .75 foot and remember that post-glacial time is probably nearer 10,000 years than 5,000, there has been ample time for the destruction of many large drumlins to the east of the Winthrop shoreline since first they were exposed to the waves of the sea.

Extensive Subsidence of Remote Date.—The presence of the sand plain at Winthrop village, the surface of which is about 40 feet above sea level (page 50), means a correspondingly high water level at this place at the time of its formation. Such a high water level could have been formed by a former higher stand of the sea, or by the development of a marginal glacial lake in this area. That the plain was not deposited in the sea or an arm of the sea is indicated by several facts. In the first place, as has been shown, there is no other evidence that the sea stood at a higher level in this region; there are no elevated wave-cut terraces or beaches. It is difficult to conceive of the formation of a gently sloping, evenly stratified sand plain like the Winthrop example in a body of water agitated by waves and tides. There is independent evidence that a body of quiet water occupied this area afforded by the blue clay that underlies the marshes and harbor (Crosby, page 364). This clay is well exposed in a brickyard northwest of Young's Hill and east of Revere. The upper surface of this clay is 4 or 5 feet below the level of the marsh and the deposit is at least 30 feet in thickness. It consists of a fine blue rock flour through which are scattered striated boulders, as if dropped from floating ice. It is without fossils and an occasional layer of sand or fine gravel is found between the thick layers of clay. The hypothesis that the sandplain was formed in an ice-dammed lake at this higher level well explains these facts, while the theory of its formation in the sea with subsequent elevation does not.

That the Boston-Winthrop area has been depressed since glacial times seems no longer open to question. Whether the drumlins were formed at their present level as the ice advanced into the sea and were then uplifted before the period of depression, or were formed at a higher level, has not been determined; but the determination is not necessary for our present purpose. "The harbor as we know it came into existence with the subsidence of the land to approximately its present level and the inner harbor at least is confined almost wholly to valleys previously formed by fluvial erosion in the blue clay" (Crosby, page 364). Nearly, if not quite, every submarine channel and tidal estuary of this region is a continuation of a stream channel. The upper surface of the clay and till which form the harbor bottom are yellowed by oxidation from 10 to 30 feet below low-tide level, proving that it was long exposed to the air. Above this clay now rest deposits of silt, which in certain areas are inter-stratified with beds of peat, all below sea level. This inter-stratification again indicates a slow but irregular submergence, periods of sinking alternating with periods of little or no change. That the beginning of the deposition of the silt and peat was long ago is indicated by the fact that many of the fossils in the silt represent forms now extinct in the Harbor and north of Cape Cod. Professor Crosby estimates that the time of its deposition, and hence of the submergence of the area, was not less than 5,000 years ago.

The lack of wave cliffing back of the present shore line is best explained by a former higher stand of the land and subsequent depression. It was shown on page 50 that considerable cliffing is now being done in the open harbor and even in the marsh area. If no changes of level had taken place, before time had elapsed for the formation of the beaches the sea would have had access to all these drumlins and the sand plain, and it seems certain that the results would be manifest to-day in old and rather extensive wave cliffs. Even if the drumlins to the east had been so numerous as to check the force of the ocean waves, local waves formed in the open waters between the drumlins, would have effectively eroded the unconsolidated drift as they are doing to-day in the open water back of the beaches. Gradual subsidence, however, bringing the bases of the western drumlins slowly below sea level, at the same time that marshes back of protecting beaches were occupying the depressed areas, will explain the absence of ancient cliffing on the drumlins back of the outer shoreline.

The evidence of remote subsidence, therefore, consists of, first, the presence of harbor channels continuing the river courses; second, the oxidized condition of the blue clay of these channels to depths of 30 feet below low tide proving long exposure to the air; and, third, the lack of ancient cliffing on the drumlins rising above the marshes.

Recent Subsidence of Slight Amount.—The evidence of subsidence in Boston Harbor during the past century is based upon the following evidence as collected by John R. Freeman, C.E., in 1903 (page 530):

1. The floor of the dry dock at Charlestown Navy Yard now stands 9 inches lower relatively to mean sea level than it did 72 years ago, while the dock stands at the same level relative to the land.
2. Comparison of tide gauges indicates subsidence.
3. Extreme tides in great storms appear to show progress toward greater heights.
4. At many points tree trunks are found standing in salt marsh.
5. Comparison of old and recent soundings at ledges and rocks indicates sinking.

The first of these evidences is most convincing. The others are less valuable as proofs, but considering the evidence as a whole it seems probable that slight depression has taken place during the last century. But that any great amount of subsidence has occurred in recent times seems very improbable. Any considerable subsidence since the formation of West Winthrop Beach would have brought it below sea level. It must be said, however, that the lower elevation of the West Beach indicates some subsidence since its formation. D. W. Johnson and W. G. Reed (page 187) have shown that a similar west beach at Nantasket stands nearly, if not quite, as high as the present Nantasket Beach, and that the history of that section which lies just south of, but adjacent to, Winthrop, is opposed to any considerable subsidence during a long period.

In conclusion, it may be said that the Winthrop area has subsided since glacial times, probably not to exceed 35 or 40 feet. This subsidence has been irregular as to rate and probably intermittent in time. During recent time a slight subsidence is indicated, but there has been comparatively little depression at least since the formation of West Winthrop or West Nantasket Beaches. Presumably the greater part of the total subsidence occurred long before those beaches were built. No account has been taken on preceding pages of the possibility of periods of slight elevation during the general subsidence. Such elevation would halt development of the shore line and add to the length of the time intervals for which estimates are proposed.

Whatever changes have been wrought in bringing the Winthrop shoreline to its present form, man has now largely checked the work of the waves. Every drumlin from South Head to Beachmont is protected from the sea by a heavy stone wall which effectually prevents further retreat of the drumlins except as these walls may be insufficient during the strongest storms. Without this protection the time would soon come when every drumlin would suffer the fate of Nix's Mate or Cherry Island. Grover's Cliff, Winthrop Head and North Head would soon disappear, leaving only a part of Signal Hill which would be tied to the rapidly disappearing Winthrop Highlands by an elongated and enlarged Winthrop Beach. Soon, however, the ceaseless waves would level even Signal Hill and, this last guardian of the harbor having fallen, the beach would be pushed aside as a curtain and the quiet waters of the harbor would be overrun by the Atlantic waves. This would come to pass, at the present rate of recession, in somewhat over 2,000 years. If, during this same period, subsidence should continue at the rate of a foot per century, not only would the open sea reach the city of Boston, but it would invade many of what are now its busiest streets.

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1860-1908. Charts and surveys of Mass, Harbor and Land Commission, State House, Boston.

1903. Boston Harbor, U. S. G. S. Topographic Map.

1904. Boston Harbor, U. S. Coast and Geodetic Survey charts. Scales 1/20,000 and 1/40,000.

1905. Plan of Grover's Cliff, showing recession 1891-1898 and 1903-1905. U. S. Army Engineers Office, Boston.

1909. Plan of Winthrop Head showing recession 1860-1908, and intermediate periods. Whitman and Howard, civil engineers, Boston.

A NEW MODEL OF THE STATE OF WISCONSIN.

W. O. HOTCHKISS,

STATE GEOLOGIST.

The model of Wisconsin from which the accompanying cut was made has just been completed by the State Geological and Natural History Survey. The making of this model was undertaken for the purpose of furnishing to the schools, libraries, and other public institutions of the state a means of giving a concrete idea of what the surface of the state looks like, and how the various surface forms, soils and rocks are related. The model work was done by Mr. E. H. Lorenz under the direction of W. O. Hotchkiss and F. T. Thwaites.

There is no science whose rudiments are at the same time so interesting and so easily acquired by the elementary student as the science of the common forms of land surface which constitute the most imposing objects of his daily landscape—the science of physiography. When a person learns to appreciate that the hills and valleys and plains are due to the same slow process which he sees at work daily—the gradual breaking up and wearing away of the soils and rocks by the rains and streams, by solution, and by the action of frost and vegetation—he has very considerably increased his breadth of view; he begins to appreciate the enormous amount of work that nature accomplishes by her seemingly slow and insignificant processes simply by keeping at work for hundreds and thousands and millions of years. He learns to look on the "eternal hills" as but temporary stages in the work of making over the land surfaces.

The model was constructed for data collected largely for the preparation of a new geologic map of the state, and is the most accurate and most finely detailed of any model known to us which shows so large an area. The detail shown on the model can only be partly appreciated from the cut. It can be better understood from the fact that it took over six months to make the first one from which the reproductions are made—part of which time three men and most of the time two men were employed on the work. It is very durable, being made of a special mixture of plaster of paris and papier mache reinforced with steel netting which is fastened to a strong, deep wooden frame. The horizontal scale is 7 miles to 1 inch, making a square township just a little less than an inch across. The size, framed, is 49 by 45 inches, giving an area twice as great as the state railroad map.

As shown in the cut the model was finished in a single color so it would photograph distinctly. As supplied to schools and other institutions it is painted to show any features desired, such as geologic formations, soils, drainage basins, forests, etc. The form recommended for school use is the one showing the geologic formations as this brings out clearly and simply the relations between the various types of topography and the underlying rocks.

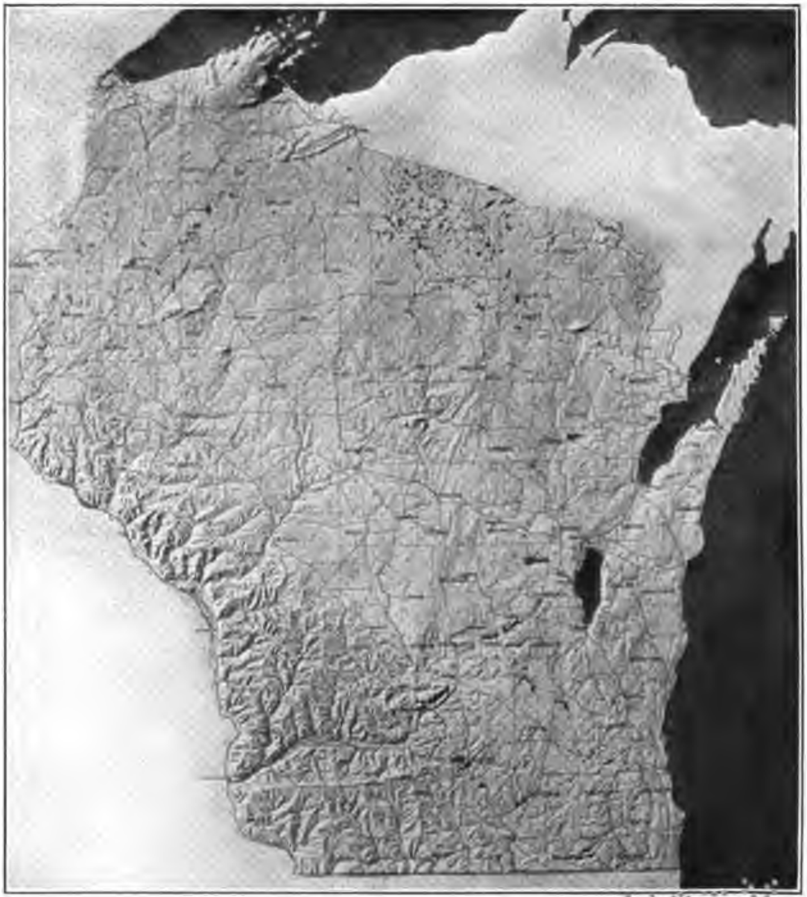
The model shows drainage, railroads, cities, county boundaries and names, and has under the title (which is in smaller compass than shown in the cut) a brief description of the topography of the state written in non-technical terms so that the various features of the model may be easily appreciated by one who has never studied geology or physiography. This description is given here, as with the cut it gives a good idea of the model. There is also a complete geologic legend giving a description of the various formations, with their thicknesses and economic products.

TOPOGRAPHY OF WISCONSIN.

"Wisconsin possesses a great variety of topographic forms. The oldest is a great area of crystalline rocks worn down by long ages of weathering and stream action from an original condition that must have been more or less mountainous to a gently rolling surface above which the remnants of the hardest rocks project as hills. This type formerly existed over the whole surface of the state but is now best shown in Marathon County.

"On this old flat surface the sea deposited the nearly horizontal sandstones, shales and limestones that cover, in crescent shaped belts, the southern half and the eastern and western edges of the state, and also a small area on the Lake Superior shore.

"When these horizontal rock formations were raised above the sea the streams and weather began to wear them down. The weaker rocks were worn away rapidly and the stronger rocks more slowly.



MODEL OF STATE OF WISCONSIN.

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As a result there are prominent limestone ridges, such as Military Ridge, extending from Madison west to the Mississippi River, and the Niagara Escarpment, making the eastern edge of Green Bay and Lake Winnebago and extending south to Waukesha County. As a result of this differential resistance to erosion there are narrow valleys in the hard limestone and wide valleys in the soft sandstones and shale. The Wisconsin river illustrates this. Its mouth is in resistant limestone and the valley is narrow. South of Richland and Sauk counties the valley is in weak sandstone and is much wider.

"The resistant limestones stand as continuous ridges, as in Grant and Crawford counties, but where the sandstone forms the divides it has been eroded to a much greater extent, as in Buffalo, Trempealeau and Monroe counties, leaving a row of more or less isolated peaks where the ridges once were. This process was carried further in Jackson and Juneau counties where the sandstone was worn to a great sandy plain with only a few harder parts of the sandstone projecting as mounds above the general level.

THE GLACIAL FEATURES.

"After the surface of the state was developed to about this stage ice invasions from the north covered all but the southwest quarter of the state. This Driftless Area shows the kind of topography that existed in the other parts of the state before the glaciers came. These glaciers moved across the country, wearing down the hills somewhat and filling up valleys, sometimes to a depth of 500 feet. The drainage systems were thus obliterated, and thousands of lakes and swamps were formed in the uneven glacial drift. Numerous waterfalls and rapids also resulted, giving many sites for the development of water power.

"The large amount of silt, sand and gravel carried by the streams from the melting ice filled the stream valleys. As a result of this filling the Mississippi bottom lands are over 150 feet above the rock floor of the valley. On the eastern edge of the state the glacial lakes left large flat areas of clay deposits which make rich level farm lands and valuable brick-making material.

"The borders of the ice sheets (as shown on the models by the dashed line) are in many cases marked by knob and kettle ridges called moraines. There are long low hills, called drumlins, in Dane, Dodge, Columbia, Jefferson and Fond du Lac counties. Their long dimensions correspond with the direction of movement of the glacier which formed them.

INFLUENCE OF THE TOPOGRAPHY.

"The influence of the topography upon the history and economic development of the state is worthy of attention. The old water routes like the Fox-Wisconsin, are to be seen, also the features influencing the location of cities, railroads and industries based on water power. The influence of the topography and soil on agricultural conditions as well as on the relative development of different parts of the state is easily seen by one acquainted with agricultural conditions."

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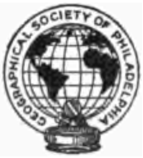

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